Metals and Alloys

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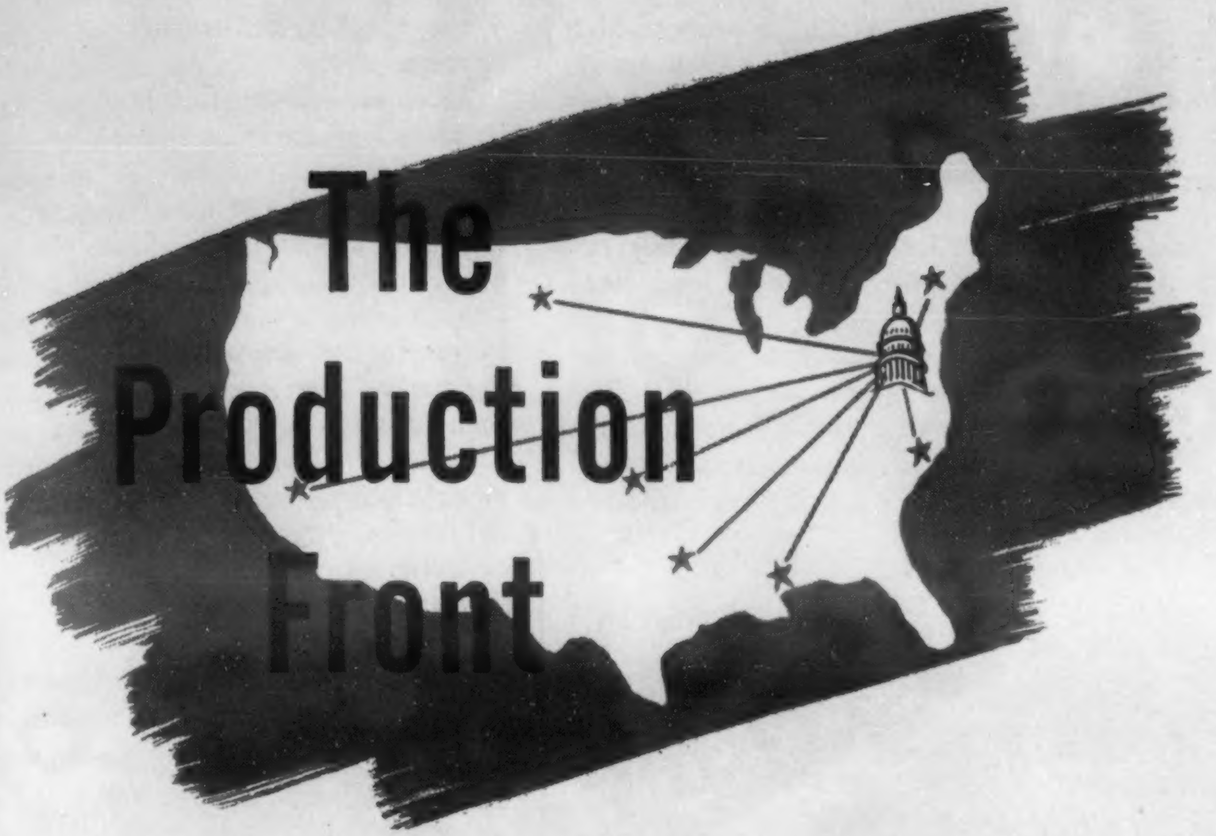
This Month

Every Month

Metallurgical Engineering Digest

The Production Front



by Harold A. Knight
Associate Editor

Important problem is to keep war production balanced. . . . We lose much potential scrap because so much material is shipped out of the U. S. A. . . . Labor must be made to "stay put." . . . Army is using over 800 substitutes. . . . Photos replace blueprints to hasten production. . . . Ingenious gadgets used for switching plate making to strip mills. . . . WPB shifts personnel rather than functions.

Smaller War Plants Corp. won't pull rabbits out of hats. . . . They are putting heat to "frozen" copper. . . . "Moly," the trump metal, gets scarcer. . . . Only a few foundries are actually equipped to cast magnesium. . . . The Gestapo collects scrap in Germany! . . . Metal price advances have been 11 per cent. . . . Are we self-sufficient in tin? . . . Lead and zinc are now recovered from "pillars."

Era of Ingenuity and Makeshifts

Our huge war production becomes a sort of Frankenstein monster, which, if not controlled, will wreck mere man who created it. Care must be taken to keep this mammoth machine symmetrical, with no excessive weight here, which might topple it over from top-heaviness, or depressions and fissures there, which might lead to cracks and failures.

Correct balance and timing is one of the chief needs of the hour. So much concentration on production of ship-plates was given that a dearth of shapes, to be used in conjunction with plates, resulted.

So much energy was devoted to expanding old plants and building new ones that we forgot we might not have the raw materials to supply production. Now there is serious talk of tearing down some plant buildings to salvage the steel and metals in them, or at least to abandon plans to construct certain new buildings.

The same may be the fate of the plan to increase steel output by 9,710,000 tons yearly. If we are worried about scrap to keep present capacity of 88,509,970 tons occupied, what about the 10 per cent capacity increase? Wouldn't it be ironical (no pun intended) if we had to tear down some of our present operating blast furnaces to supply scrap?

Of course, certain balance should accrue as a result of the PRP reports, a system which should be working smoothly when this is read. That has been our first all-out attempt to take an inventory of our on-hand resources. Hereafter, we should be able to ship certain metals from zones of comparative plenty to those of leanness.

Salvage Potentialities Shipped Abroad

We are at a disadvantage, as compared with Germany, for instance, in that we are shipping so many raw materials and finished products outside our country, both on Lend-Lease and to our armed forces. We have, therefore, even lost them for their salvage value. It is estimated that Germany salvages at least 90 per cent of spent material on the battlefield and within a few weeks it reappears as finished raw material.

"Need for salvaging" are by now household words. Seems as though our best hope now is recombing old combings, operations already well-known in gold mining. Old junk dealers were able to recall where old tires were buried under city dump heaps at times when scrap rubber prices were low. Recently they were recovered.

The same is true in metal scrap. Old railroad maintenance men have

recalled where pipe in abandoned shops was hidden underground; worn metal parts were hidden in basements, old wells, or thrown into rivers.

Patriotism Vs. Financial Incentive

History has shown that much hidden scrap can be recovered when there is an incentive. A few years ago, heavy melting steel scrap reached $26 per ton ($20 today). This high price incentive brought out astounding quantities from sunken ships, abandoned buildings and bridges. Patriotism today must take the place of high price incentive of a few years ago.

The other chief element in production, aside from materials is labor. Schedules for the last half of 1942 call for 5,000,000 workers added to 12,500,000 already in direct war employment, with the major increase in women.

But labor is being coddled, featherbedded and sung sweet lullabies. The time is near at hand when, despite the New Deal, labor must be drafted with as firm a hand as our soldiers. Wage advances before elections must approximate zero.

Moreover, labor must stay put or be moved where most needed. Metal production at the mines is due to slump badly because miners are leaving mines to work in munitions plants where they often get two or three times a miner's wages. They are no longer in the damp dark bowels of the earth. They work in cheerful surroundings, with, perhaps, music to listen to over loud speakers and girls to ogle.

Likewise, brass makers complain of difficulty of holding labor because they can't get enough copper to keep busy over 35 to 40 hours per week. Besides, many new plants, financed with government funds, can afford to do more to attract labor than privately-owned plants.

Army Is Using 800 Substitutes

"Substitutions" is by now another household word. Even our armed forces, for whom at first nothing was too good, have had to knuckle down. Our army was using 800 substitutes on July 1 (perhaps more now). Substitutions for bronze finishes have been used for 174 products; in 116 items brass has been eliminated; zinc has been cut out from 93 specifications; nickel from 78 items; copper from 66; bronze from 68 and aluminum from 58. For much equipment substitutes have been found for cork, chromium, cadmium, nickel, steel and rubber.

They say that the Navy is more difficult to persuade to climb on the substitution bandwagon. This may be because Navy equipment is more subject to corrosion and because worn out equipment is less easily replaced, especially when far from bases.

Photographs Replace Blueprints

Short cuts and makeshifts on our production front are America's "new order" of the day. Photographs of designs and processes often supplant blueprints, partly because many of our nouveau engineers can't read blueprints. Moreover, a series of photos from several angles often gets the design idea across more rapidly. A large steel manufacturer recently used photos to good advantage to give other steel makers a quick slant on a common problem—armorplate, as we recall.

One of the steel industry's major problems was to convert strip mills to

steel plate manufacture. Successful it must have been, because June output was 489,704 tons of plates from strip mills that were producing none a few months ago. (May output was 425,211 tons). It exceeded sheared plates in June.

Problems involved in rolling and handling plates, one inch thick, as compared to sheets 1/25 in. thick, are obvious. Need of additional space to house and handle heavy plate has often handicapped. Partitions have been ripped out, walls moved and other expedients undertaken. Stronger cranes and shears were needed. Often new equipment was not available and it was fabricated from "bits and pieces."

Output Record with Old Equipment

Irvin works, Carnegie-Illinois, took a steamdriven shear of nineteenth century vintage, coupled it with an old roller-leveler and reconditioned both into a modern electric-driven finishing line. It has produced a record of 636½ tons of plates in an 8-hour shift with a green crew.

Campbell plant, Youngstown Sheet & Tube Co., had no place for cooling tables, shears and finishing equipment for their plate mills. So sweating crews move hot plates into freight cars, which carry them six miles to the Brier Hill plant to be finished on equipment forming part of a mill built in the first World War. Jones & Laughlin's Pittsburgh works picked up an abandoned gravity conveyor to move its plate from one building to another.

"Doers" Step Out Front in WPB

Basic difference between the most recent "realignment" of the War Production Board and previous reorganizations is that it is a shift of administrative personnel rather than functions. Ineffective bureaus and branches will probably remain—it is too much to expect that many will be dropped from Government payrolls.

Significant facts:

Donald Marr Nelson steps into the role of international statesmanship in the United Nations armament effort, and

William L. Batt will assume the operational and policy direction of WPB, as his deputy.

Most important man for American industry's contacts is Amory Houghton, who, as Director General of Industry Operations, will handle the growing maze of industry and commodity branches and their respective advisory committees.

James S. Knowlson heads up the policy determination effort. Little has been done to coordinate WPB policies in the past, and it is expected by careful observers of the Washington scene that this will be one of Mr. Knowlson's first jobs.

Six functional divisions will be organized under Mr. Houghton, four of which stem from previous divisions or bureaus. These are the Divisions of:

Priorities Administration:

Conservation, with its substitution, simplification, and specifications activities,

Industry Advisory Committees, heretofore under Mr. Houghton's administration, and

Inventory Control, which recently announced the Production Require-

ments Plan (PRP, nicknamed "Purp").

Two new divisions have been added:

Facilities Utilization, which will put the emphasis on securing present utilities for Government contracts instead of securing Government contracts for distressed plants—the program of the late Contract Distribution Service of WPB, and

Production Engineering. This stems from nothing in OPM, SPAB, or WPB, although WPB officials have been kidding themselves that the Contract Distribution unit knew something about production engineering. Almost everything remotely related to production engineering has been stimulated by the Army and Navy. The Production Divisi6n of OPM and WPB has dissolved, and the ablest men have gone into the Army and Navy. Some WPB officials play with the fancy that these men were "trained" by WPB, and were then "assigned" to the Army and Navy.

Prospect: Because this realignment of WPB was more the planning of the WPB executives than "masterminding" of brain-trusters, and because it emphasizes the men who have grown up with OPM and WPB, it should help the war effort.

No Miracles from SWPC

Expect nothing miraculous from the Smaller War Plants Corp., established by an act of Congress and operated by the War Production Board under Lou E. Holland. With a $150,000 capitalization fund earmarked, it is only a political gesture for vote-seeking congressmen because:

(1) Small business already has financial aid from numerous Government agencies, including: Army, Navy, Reconstruction Finance Corp. and its numerous "emergency" subsidiaries, and the War Production Board itself in some cases.

(2) The chief problem of small business has been that this area of manufacturing was, to a large extent, unable to get war contracts. Reasons:

(a) The Army and Navy prefer to let contracts to large, well-staffed, well-financed corporations, who, in turn, subcontract parts of the jobs. Thus, the procurement agencies have fewer contacts to make, and can control inspection and shipments—and the numerous specification changes.

(b) Small plants usually depend upon Army and Navy for detailed information as to manufacturing—and neither is equipped to supply such information.

(c) WPB's late Contract Distribution service failed to supply production engineering data to smaller plants, and failed to help them to get contracts from the procurement agencies of Government.

Steel Recovery Corporation

"Frozen" steel in the hands of civilians who have been forbidden to continue manufacture of peace goods will soon be disposed of through the newly-organized Steel Recovery Corp. Much of this steel is of course semi-fabricated or perhaps completely finished.

Where possible the material will be transferred to war work in the form it now is in, through private sales, the Steel Recovery Corp. to perhaps act as a go-between.

What steel cannot be used "as is" will be assigned a salvage value, prob-

ably, which will be higher than its mere scrap value in recognition of the labor already expended on it.

Headquarters of the Steel Recovery Corp. will be at Pittsburgh, partly to decentralize activity out of Washington and partly because Pittsburgh is a steel center from which help will be recruited, many of whom are already conversant with the various forms of steel.

George L. Stewart, vice president of Edgar T. Wards' Son Co., Pittsburgh, steel distributors, has been elected president of Steel Recovery Corp.

By the end of this month the first of 250,000 inventory report forms will be mailed to known holders of frozen iron and steel, including 37,000 owners of stainless steel. Accompanying the letters will be price lists at which the government will compensate holders for surrendering their material.

City of New York Holds Steel

Quite possibly the city of New York is a holder of such steel. Considerable criticism has been voiced (We have been called up by irate citizens) because the city has been laying down steel curbing in the place of the usual stone. Such curbing is in the form of plates, or angle plates, about 3/4 in. thick.

It was stated by a city official at mid-July that 3,750 tons of such plates are still the property of the city, costing $250,000. The material had been offered to the WPB and to the Army and Navy, all turning the steel down.

Now perhaps the Steel Recovery Corp. will find a berth for it.

Frozen Copper Being Thawed Out

About 1,000 tons of "frozen" copper from abandoned manufacture of civilian goods is being turned in weekly for production of munitions, tanks, planes and ships as the result of the efforts of Copper Recovery Corp., newly-organized as a subsidiary of the Metals Reserve Corp.

Judging by experience of the first 15 days, 20 per cent of this semi-fabricated copper can be used "as is," the other 80 per cent to be considered as scrap, paid for at "salvage prices," between 18 and 30 cents per pound as against usual scrap of around ten cents, and eventually be remelted. Probably around 250,000 tons of copper is frozen, and in possession of 100,000 holders, though this falls far short of solving our copper problem, the No. 1 critical metal.

An amendment to the Copper Order (M-9-a, Aug. 2, 1941) is due to be issued soon. It will combine all orders on this metal and their amendments, with view to:

Simplification of the routines for control, and

Plugging up several loopholes.

Copper Branch (WPB) executives agree that the only important relief in prospect is the possible discovery of rich veins in the mines now being worked on a 24-hour basis.

"Moly", NE Steel Trump, Is Scarcer

Molybdenum, backbone of the National Emergency (NE) Steels, is becoming so scarce that several Army contracting agencies have warned manufacturers to "go easy" with this material. Reasons:

(1) When the NE steels were issued, substituting molybdenum for more critical materials, the swing to this element cut deeply into the supply, and

(2) Large increases of shipments have been made to Great Britain and Russia under Lend-Lease.

Prospect: Expect tighter controls of molybdenum—until some metallurgical genius finds another substitute, or intensively develops the field of atomic structure of iron.

NE steel tonnage is rising rapidly and will probably be up in the 6-figure range for August. Ultimately, they should constitute 1/3 to 1/2 of our total alloy steel production. The drain on "moly" is likely to become critical unless something is done to lower the molybdenum content of the present NE steels.

Actually, WPB is working on 3 new series of National Emergency Steels that will ease the molybdenum situation:

(1) still experimental:—a series similar to the present NE 8600-8900 steels but with molybdenum 0.08 to 0.15;

(2) definitely coming:—a series that permits complete utilization of the alloy residuals of scrap—will contain up to 0.50 per cent Si, 0.20-0.40 Ni, 0.20-0.40 Cr, 0.10-0.20 Mo;

(3) also definitely coming:—a manganese - chromium - silicon type of steel that contains no nickel or molybdenum, which will be made by producers having unusually pure scrap.

Few Foundries Will Cast Magnesium

Only a few foundries will be able to re-equip to cast magnesium, despite the impression given by WPB that gray iron foundries generally would be included in the program to cancel plans for building new magnesium casting facilities.

Newer and better equipped foundries of General Motors, General Electric, Chrysler, and several large companies will be used for this purpose, saving thousands of tons of steel and other materials proposed in an earlier WPB recommendation for plant expansion.

Ford and several other large companies have built magnesium foundries and have trained men to handle this material.

Scrap, "Unc" Sam and the Axis

Reader, if you were a German, you would be collecting metal and other scrap under the orders and supervision of one Heinrich Himmler, Gestapo chief. Ever hear of him? Stop quivering! Try to be calm! Let Himmler or his gestapo catch you with metal not in use and which you have not turned in—concentration camp, or worse. Moreover finished items, such as castings and spare parts, not in war use—take 'em to Himmler!

According to a Berlin domestic broadcast, material to be collected "includes in particular old iron, unprocessed iron and steel material, of unusual kinds and measurements, half finished iron and steel material and castings from cancelled orders, finished iron and steel products and finished castings which had been stocked by industry and the armed forces as spare parts, but which, owing to a change of types, are no longer needed, and, finally, shut-down plants under special conditions."

Failure to comply falls under penal stipulations of the order of the Fuehrer of March 21.

If you were an Italian, you would be asked to tear down all ornamental iron work and metal handicraft of incalculable historic value such as occurs so lavishly in your cities of beauty and culture, such as Florence, Venice, Pisa. You must give these to be melted up into armament.

You would turn in any automobile registered prior to Jan. 1, 1930. Your government is so desperate for ferrous raw material that it is trying to utilize the iron-bearing coastal sands, but actual production is said to be negligible.

If you are an American, you have just been told that the nation-wide goal is 17,000,000 tons of scrap iron and steel collections by Dec. 31, 1942. States have been assigned quotas. Pennsylvania leads with 2,978,000 tons; then Ohio with 2,175,000 tons. New York is to furnish 1,208,000 tons, New Jersey 492,000 tins.

You, Mr. American, will not go to jail for being remiss. But—

Metals Price-Advance Very Slight

During the 33 months from August, 1939 to April, 1942 prices of metals and metal products have risen only 11 per cent as against a rise of 71 per cent for farm products, according to figures compiled by Office of Price Administration.

The general maximum price regulation was issued April 28, 1942, at which time all commodities, not already under a ceiling plan, were so regulated. By April 18, 1942, a date used in this study, 92 per cent of metals and metal products were already under OPA controls, whereas only 3 per cent of farm products, which undoubtedly accounts for the sharp rise in the latter.

During the 33 months studied, only fuel and lighting materials experienced a lesser increase than in metals, by 7 per cent. Among the sharper increases were foods at 47 per cent, textile products at 44 per cent and chemicals and allied products at 31 per cent.

Self-Sufficient in Tin?

The new tin smelter in Texas, the only one in the United States, will produce 40,000 tons in 1942, though it is rated as capable of producing 74,000 tons yearly. The United States consumed about 70,000 tons in 1939, but of course war consumption, assuming supplies were abundant, would naturally run much heavier. Our war economies on tin have been drastic and a tin authority estimated recently that we can easily get along with 50,000 tons yearly. Tin concentrates at the Texas smelter are received chiefly from Bolivia. There is tin in Alaska, which might supply some of our needs, especially after the completion of the new highway to there.

Potentialities of a tin smelter in Oruro, Bolivia, are being investigated by the Bolivian government on the ground that it would be more economical to ship out pig tin than concentrates. The proposed tin smelter in Chile has given impetus to the Bolivian project.

Lead and Zinc from "Pillars"

To increase our lead and zinc supply thousands of tons of ore in "pillars" of mines can be recovered by "geophones," which are instruments for subaudible warning noises, amplified electrically up to 10,000,000 times. Pillars are the mining ground

which are left undisturbed when hollowing out caverns in the course of mining, being used to support the upper levels or roof.

As these pillars are dug into, geophones reveal whether there is danger of cave ins. The resultant strains in the earth's crust cause noises in the instrument.

By counting the number of noises per minute as recorded on sensitized paper and integrating the results for several hours or days geologists are able to draw up charts showing pressure conditions surrounding a pillar. Most rock noises are local, traveling less than 100 feet from the area in which they originate.

Bureau of Mines engineers have made plans for immediate removal of 13 pillars, estimated to contain 30,000 tons of ore, in one mine, and of a grade two and a half times higher than the previous average from this mine.

Naturally the Bureau of Mines is not slow in exploring for new ores and developing better processes for their recovery. The United States used over 600,000 tons of chromite in 1940, virtually all of which was imported, chiefly from the Philippines, Greece, Turkey, New Caledonia and India.

Two processes may produce unprecedented volume from domestic sources: (1) a beneficiation process for low-grade ores which has passed all tests so far and merits large-scale pilot tests; (2) an electrolytic method for recovering high-grade chromium metal from domestic ores.

Pilot plants at Boulder City, Nev., show that the new beneficiation method, a roasting and leaching process, can increase the chrome content of low-grade ore, raising the ratio of chromium to iron from 1.7 to 1 to 30 or 40 to 1.

The electrolytic method involves treatment of an aqueous chromium sulfate solution prepared by extracting chromium from chromite minerals as soluble sodium chromate. Electric energy consumed is less than half that required by the usual electro-deposition process.

The Bureau of Mines, since 1941, has been searching for new ore sources of various metals in this country. It has already resulted in outlining reserves of iron ore in excess of 40,000,000 tons. It contemplates an investigation of deposits of coking coal in Wyoming and New Mexico in addition to that now in progress on Utah coals.

More than 2,500,000 tons of chromite ore and 2,000,000 tons of antimony ore have been indicated and a substantial reserve of tungsten has been uncovered from which production began in September, 1941. Reserves of manganese ore have been increased by several millions of tons.

Alaska will be explored for antimony, chromite, mercury, molybdenum, tin and tungsten.

This, That and the Other Thing

Conservation item: manganese steel trackwork is now being confined to rail locations of extremely severe service, such as switches, rail crossings, etc.

That the public often has a most sketchy knowledge of metallurgy, to put it mildly, is illustrated by collections of collapsible toothpaste tubes. Many items sent in had not a trace

of tin, even to the third decimal point. Such an extreme item collected at the plant of Tin Salvage Institute, Newark, N. J., was a sewing machine made in 1858.

The vortex of the No. 1 blast furnace, Hamilton plant, American Rolling Mill Co., was repaired while the furnace was producing—perhaps for the first time in history. But this is war time! Three days were spent in planning the job to insure safety to the eight workmen. No injury resulted. Each workman received individual recognition from the War Department.

Because of a coal shortage, the steel industry of Sweden has been compelled to replace 60 per cent of its coal with wood.

Torch cutting and welding is America's No. 1 industrial fire hazard so far this year, according to the National Fire Protection Association, Boston. Reasonable precautions will keep this hazard from shutting down your war plant!

It is proposed to tear down New York City's famed aquarium, scene of Jenny Lind's triumph. Presumably some valuable scrap metal would result from its demolition, since within recent years it was given a new Monel roof.

Because of scarcity of steel, makers of crushing and grinding machinery propose to use pebbles in place of steel balls.

For promoting morale and speeding work at plants of Cooper-Bessemer Corp., various indicators of progress are installed. In a foundry is a thermometer recording increasing tons of castings produced. Near this is an enormous kettle in which are boiling the abject figures of Hitler and Hirohito. Elsewhere is a large thermometer showing the production in horsepower of diesel engines. Individual departments have their own indicators.

Australians Use U. S. Standards

Watch for increased use of American standards and chemical specifications in Australia. Australia's standards are generally based upon British Imperial specifications, but the Commonweath is depending more and more upon the United States for machine tools and technical aid.

Australian officials have been seeking services of competent standards engineers, trained in American industries. Never strong in technical experts (per capita of population basis), Australia has lost many to its armed services, and is losing more each week.

Fewer Scrap Fumbles and More Goals!

Despite the urgent need of scrap materials to ease the critical situations in almost every metal, WPB's Conservation Division has not approached the problem from an engineering point of view, and little important value should be placed on the ballyhoo being raised to get scrap back to the processors.

An analysis of the best programs in individual progressive shops (for example, the systems described in the Salvage Section of this issue) would go far as instructions to backward factories.

This administrative fumble will reduce the Government's hopeful estimates of its salvage campaign, because the fact is that too many factories have had no practical experience with the scrap segregation problem.

Just telling them that scrap is needed and that they must collect and segregate it isn't enough. They need to know *how!*

"LUMP" to Supplement "PURP"

The "little fellow," the manufacturer who does not use over $5,000 worth of metal in a quarter, and has not been eligible for a priority rating under Production Requirements Plan but has continued use of the various "P" orders, will soon have recognition.

This is to be called the Limited Users Metal Plan, or LUMP, by which small users of strategic metals can be granted priority aid on essential requirements.

LUMP will go into effect in sufficient time to govern last quarter operations of 1942.

By Oct. 1 companies who use less than $5,000 worth of metal per quarter and who need priority aid on what they purchase, whether for production, maintenance and repair, or operating supplies, will be required to apply on the LUMP application form.

No More Silver Linings for Clouds

One of the perpetual headaches and heart breaks of the present era is that just when a substitute metal or material was nicely adapted to the work in hand, it, too, became scarce. Now silver goes the way of so many alternates.

New WPB order M-199 rules that after Oct. 1, 1942, no civilian may process any foreign silver, this having been selling at 35⅛ cents per ounce. Domestic silver sells by law at 71.11 cents to the Treasury. None of the silver owned by the Treasury may be sold at less than $1.29.

No foreign silver whatsoever was available for non-essential purposes for the silversmiths, platers, jewelry manufacturers, mirror makers, photo engravers, etc. in July, nor in August.

The use of foreign silver for direct war purposes and essential civilian purposes has increased tremendously, such as for silver brazing alloys, bearings and contact metals.

It is ironical that the Government, who preaches against hoarding, is itself a flagrant hoarder of silver. Such are the paradoxes and inconsistencies of politics!

We Go Back to Wood

The city of Baltimore will use wooden pipe in new water system projects. They will be octagonal in cross sections, constructed of small pieces of lumber joined together and will be fastened with wooden dowels instead of steel hoops.

Six thousand tons of steel will be conserved by using wood in the construction of 5 Westinghouse war plants. Beams of Douglas fir wood are fastened with steel joint connectors having 3 times the holding power of designs 20 yrs. ago.

An emergency building of wood with brick facing was thrown up in 90 days by Allis-Chalmers Mfg. Co., covering 200,000 sq. ft. Metal caps to join the ends of timber stresses and columns were cast in Allis-Chalmers' own foundry.

Molybdenum may be melted only after approval of melting schedules as provided in Order M-21-a or by specific authorization, the Director General for Operations, WPB has ruled in a revision of Order M-110. The action places molybdenum under the same restrictions as vanadium.

Mother Writes to Strikers

Here is a mother who should get a gold star for her deep-from-the-patriotic-heart-letter to the strikers at the plant of General Alloys Co., makers of severe service alloys, Boston.

> To the Striking Workers at General Alloys:
>
> "We women whose sons must fight this war, where cruelty and speed outdo each other, read with shame and anger of your desertion in your country's hour of need. Beware lest your own mothers curse you, and your own children cry out in terror at what you can now prevent.
>
> "Selfish and blind you must be not to see that such work as yours must continue and increase many times over, lest the Nation die. If you cannot see, we can.
>
> "Must we leave our kitchens and our houses and do your jobs for you; or will you fall to, and fight with all your skill and strength to help the boys?
>
> "We mothers need your answer, and soon.
>
> "Mrs. Florence C. Brooks,
> Milton, Mass."

Less tense, yet effective, was the song written by the committee of "scabs" at work during the strike. It runs to the lilt of "Deep in the Heart of Texas." It starts:

> "They do not fight—they would not work [clap, clap, clap, clap]
> The molders told 'em not to.
> Then William Green, comes on the scene [clap, clap, clap, clap]
> And says 'Good unions ought to.'"

And it ends:

> "Five million men—March home again [clap, clap, clap, clap]
> Have no jobs waiting for them.
> 'Twould be too bad—In fact quite sad [clap, clap, clap, clap]
> *If a hundred molders joined 'em.*"

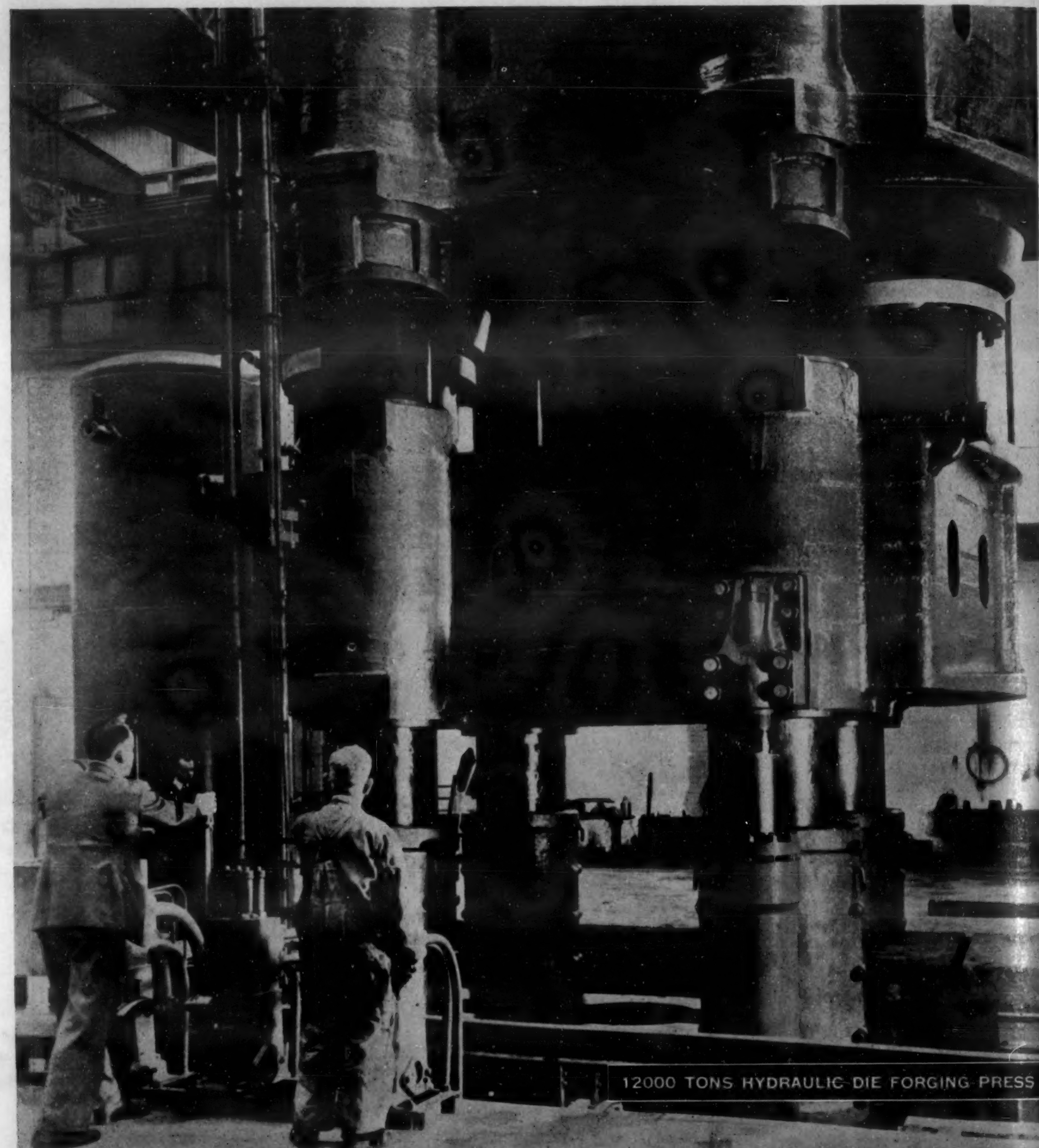
Bill Cunningham, widely-syndicated feature writer, took this strike as an occasion to write a forceful article, the introduction to which is as follows: "Labor's no - strikes - for - the - duration pledge, covering war work, is no good. Its leaders have been unable to deliver. The record of failure is in the official figures of the U. S. Department of Labor just made available [early in June]. These show only 62 per cent compliance with the patriotic pledge given the public for their bodies by William Green and Phillip Murray. These figures cover January and February, as compared with the same two months of 1941."

Army Uses Rubber to Save Rubber

Some hard-headed thinking by officers of the Army's Corps of Engineers resulted in a highlight of rubber conservation, with a goodly amount of aluminum saved in the bargain:

By using collapsible pontoons of rubber-impregnated fabric instead of rigid aluminum pontoons, the number of trucks and truck-trailer units required to transport a 1,080 ft. bridge was halved. Rubber for the reduced number of truck tires, plus the rubber for the fabric, adds up to 30,000 lbs. less than was required to transport the aluminum pontoons and other bridge parts.

Because of the large volume of Army and Navy purchases, substitutions of this type are tremendously important and will go far in winning the war.



Feature Articles

Heavy Pressed Steel Shapes

Something really big in pressed steel shapes as formed and flame-cut by Lukens Steel Co. and its affiliate is described by Cone (page 232). The finished products are offering real competition to forgings and castings, too.

Cracking Test for Cartridge Brass

Anything that saves even a little mercury these days is important, and Gisser (page 238) describes a practice in making the "season cracking" test for cartridge brass that saves a lot.

"Purging" Controlled Atmosphere Furnaces

Human beings (and heat treating furnaces in these times) are too precious to risk by "guessing" whether a hot furnace is completely purged of air before admitting the controlled atmosphere. Leslie (page 241) describes a system for foolproof checks on purging.

A Special Section on Salvage and Reclamation

If the National campaign to salvage every pound of available scrap is to be successful, more attention must be paid to the engineering factors. A special 20-page editorial section (starting on page 247) presents 10 practical articles on industrial salvage and reclamation from the engineering viewpoint. Some of its features are highlighted below.

General Recommendation for Efficient Salvage

Peters (page 249) reviews broadly the practical steps that plants should take to avoid scrap, to prolong the life of tools and dies, and to prevent contamination of unavoidable scrap. A reference table of shop reclamation methods is included.

Best Salvage Practice in Various Industries

A symposium of 8 articles—one for an industry—presents advanced salvaging practice in several fields (starts on page 253).

Scrap Identification Tests

Avoiding "mixups" is important in scrap handling. Useful in that respect should be the 3-page tabulation of scrap-identification tests—physical, spot chemical and spark (starting on page 264).

Metallurgical Engineering Digests

Aluminum Powder by a New Method

A novel method of making aluminum powder by a "flinger wheel" process, in which molten aluminum is dropped on the nobbed rim of a rotating wheel, is described by *Light Metals* (page 306).

Salt Bath Heat Treating

Some practical dope on the operation of salt baths is presented by Stewart (page 316). An interesting feature is suggestions for disposing of waste cyanide.

Finishing Aluminum Die Castings

A broad, informative review of cleaning, polishing, anodizing, painting and lacquering of aluminum alloy die castings is given by Keskulla & Edwards (page 318).

Steel Tubing for Cylinder Liners

The design and manufacture of cylinder liners made of seamless steel tubing for the Rolls Royce airplane engines produced by Packard are interestingly discussed in *Aviation* (page 338).

Beryllium-Copper Springs

Carson (page 344) holds forth informatively and at length on beryllium-copper springs, particularly for aircraft use. Properties, heat treatment and applications are reviewed.

Inspecting Aircraft Castings

A descriptive survey of inspection methods in use at a large airplane-parts foundry is provided by Rodgers (page 356).

Lowering a charge of forgings for machine-gun barrels into a Homo Method Furnace, to be low-temperature annealed prior to rough-machining. A typical use of Homo Tempering in the machine-gun plant of John Inglis Co., Limited, one of Canada's mass-production war plants.

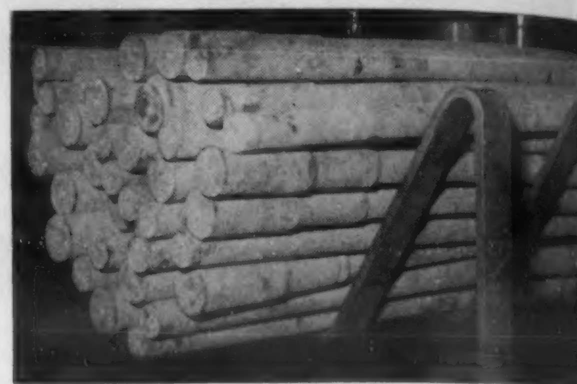
MACHINE-GUN BARRELS

Uniformly Drawn By HOMO Method

A tough problem in the making of machine guns (as in other war necessities) is to anneal the roughly-forged parts so that hard spots are completely eliminated. The parts must be so uniform in softness that their excess metal can be turned, broached or planed away in absolutely minimum time, with minimum human attention. Here's how John Inglis Co., Limited, giant Canadian munitions makers, are handling this low-temperature anneal of the barrels for tens of thousands of Bren, Browning Colt and Boice guns.

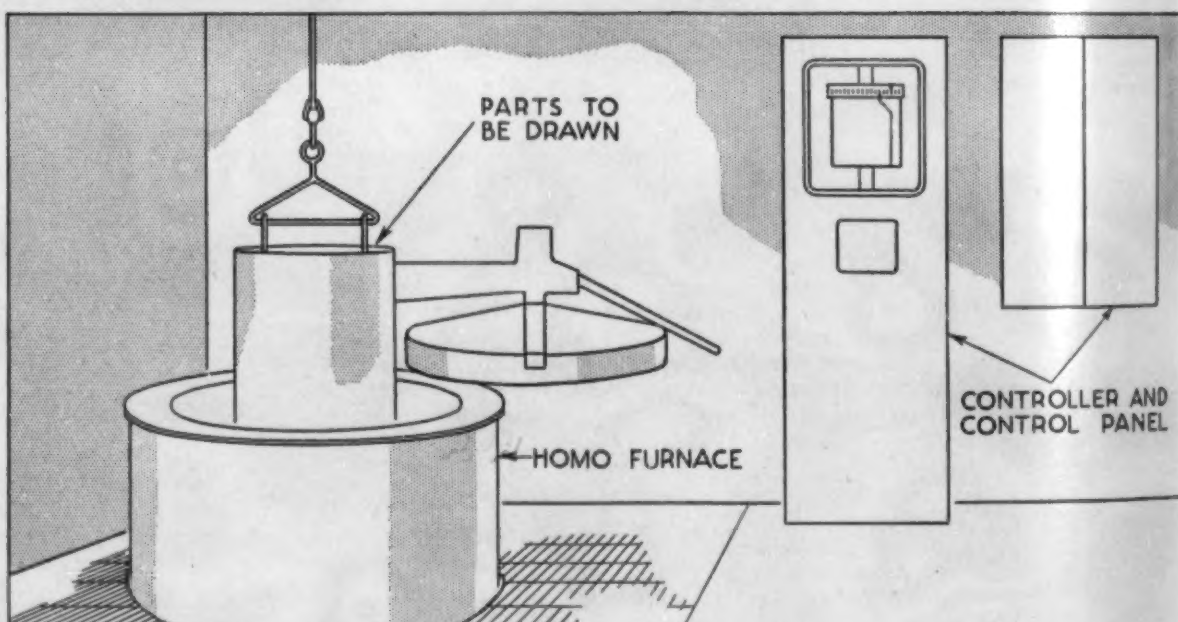
In general, the operating routine is to load the forgings into special fixtures, lower them into Homo Method Tempering Furnaces, set the automatic recording controllers and leave the equipment alone until time to unload. Electric heat, distributed by forced-convection to the exposed surfaces of the barrels, brings them to temperature so uniformly that hardness readings show practically no variations. And, when the rough-machining lathes cut great curling chips of metal from the barrels, and the boring mills and riflers work within them, the forgings go through with every advantage that correct annealing can give.

Many other gun parts go to the Homo not once, but twice—first for low-tem-



One of the thousands of batches of Homo-annealed rough forgings from which the barrels of machine-guns will be shaped.

perature annealing or for Homo-carburizing, and then to another Homo, for final tempering. For this great Inglis plant got into speedy, all-out production by using the established, dependable, up-to-date methods of industry—methods which include Homo Tempering, Homocarb Carburizing, Homo Nitriding and Vapocarb-Hump Hardening. If you have a problem in heat-treatment, the same methods can probably help you. As a start, we suggest you outline the situation in a letter, or ask for appropriate catalogs—T-625, *Homo Tempering;* T-623, *Homo Carburizing;* T-624, *Homo Nitriding,* T-621; *Vapocarb-Hump Hardening.*



A schematic layout for dependable, accurate tempering, drawing and low-temperature annealing by the Homo Method. Arrangements like this are used in hundreds of war-industry plants.

Jrl Ad T-625(27)

Pig vs Scrap vs Sponge

The scarcity of scrap for steel making has brought forth proposals to erect many small plants to produce sponge iron as a sort of *ersatz* scrap, especially since some compressed sponge iron has been imported from Sweden and so used, especially by a few tool steel makers. Compared to scrap or pig, the cost of the Swedish product has been extremely high. Its virtue has been that it was relatively pure and its low carbon content fitted it for the unusual electric melting practice in which a dead melt, without a boil, is aimed at. The tonnage so used has been small, since the price of this raw material could only be borne by very high priced finished products. Domestic production of an equivalent small amount might be advisable, say from mill scale, since ore of the purity the Swedes used for this sponge is a rarity in the United States.

Some of the Swedish sponge has been pure enough so that, after suitable grinding and sifting, it was usable for powder-metallurgy bearings, where freedom from scratchy particles of entrained gangue is necessary. Very obviously, for powder metallurgy purposes, mill scale or a chemically-prepared iron oxide will be needed as starting material, so the sponge-scrap-substitution question is one distinct from the iron powder question. Sponge for use as scrap need not be free from every trace of gangue, though obviously gangue is a drawback, increasingly so as its amount increases.

Whatever route is chosen from iron ore to finished steel, the oxygen and the alumina, silica and other impurities in the ore have to be taken out and metallic iron left. Blast furnace practice does this in two steps, the gangue is fluxed off, and the iron reduced and at the same time carbon is added. The blast furnace iron, transferred to the open hearth, supplies needed carbon for the purifying boil in the pig-scrap charge.

If we have too little scrap and must use a very high proportion of blast furnace metal, then we have more carbon than we need. In this case the blast furnace metal, or part of it, goes to the converter where it is blown to low-carbon metal, which forms a molten equivalent of scrap, with the advantage that, if used hot, the open-hearth is free from the task of melting the scrap it replaces.

In these methods, the task of getting rid of the gangue in the ore is performed by the blast furnace, which has far higher thermal efficiency than does the open-hearth. Getting rid of excessive slag is a mean job in the open-hearth, but the blast furnace is well adapted to that task.

If on the other hand, we take the same ore that ordinarily goes to the blast furnace and

Photo by U. S. Army Signal Corps

Tough Steel for Secret Process
Made by Inland for Government Arsenal

Special steel for small and large calibre guns is made by Inland for a Government Arsenal. The gun barrels are manufactured by a secret process and require an especially tough, high-quality carbon steel. Thousands of tons of this steel already have been made by Inland, and a large tonnage continues to flow to the Government Arsenal.

Production of this steel to exacting specifications begins with the careful selection and blending of raw materials. Furnaces must be in perfect condition; temperatures are controlled to the nth degree. Expert steelmakers and highly trained metallurgical technicians supervise each phase of production, from blending of raw materials to final inspection. As many as a hundred test samples are often taken as the heat progresses to make sure the chemical analysis is exactly right. A heat is immediately rejected if it does not safely meet every rigid requirement.

Ingot molds are thoroughly cleaned and prepared for hot topping. Billets are heavily cropped, chipped and ground to eliminate all possible defects. Every ton of this special Inland gun barrel steel must pass the critical examination of U. S. Government inspectors before shipment.

Inland has had many years of experience in making steels to meet special requirements. We are glad now to be able to turn this skill to the production of steel for gun barrels—and for bombs, ships, tanks and all else needed for Victory in the war against aggressor nations.

SHEETS · STRIP · TIN PLATE · BARS · INLAND STEEL · PLATES · FLOOR PLATE · STRUCTURALS

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reduce it to sponge, without melting or slagging, we have a product that includes all the gangue of the ore, and when we transfer it to the open-hearth we make the open-hearth take up the task of slagging it off, instead of the blast furnace. This not only takes time and fuel, but it necessitates modifying the fluxing and slagging procedure.

If the sponge is not to be charged hot, but is to be made at some remote point and shipped in, the sponge has to be compressed, first to prevent it from rusting in transit, and second to make it solid enough to melt easily, for the porous sponge is very hard to heat.

* * *

Against these drawbacks the virtue of sponge-*ersatz*-scrap is that the reduction may be carried out by natural gas that has gone through a "reforming" process, relieving the requirement for coke for the blast furnace reduction otherwise required. Unfortunately, the iron ore deposits that are well located in respect to natural gas supplies are impure so the resultant sponge will be impure. One might say, "we'll ship in purer ores," but it must be remembered that mining, transportation, and smelting of good grade iron ores are all balanced, all operating at capacity. If mining were increased to supply more good ore for sponge, that extra ore would have to travel the same crowded route as the rest of the ore for blast furnaces, and it would do no good to have to slow down some blast furnaces to less than capacity production to provide ore for sponge. Ore for sponge must be supplied from sources whence it can be transported without diminishing the present flow to the blast furnaces.

This necessity means that any appreciable amount of sponge is best made from new ore beds and new beds of pure ores are scarce, so the actualities of the case lead to production of sponge from impure beds near natural gas and hence to impure sponge that puts a heavy burden on the open-hearth to get rid of the heavy load of gangue.

The synthetic scrap produced through the blast furnace and the converter will serve just as so much scrap would, with the advantage, when made in the steel plant, of being charged as hot metal and speeding up the open-hearth heat. Use of sponge iron scrap, slowing down the open-hearth, means that more open-hearths or more electrics will be needed to produce a given steel tonnage. Hence sponge would act as a brake on steel production.

Those methods of making sponge that give reasonably complete reduction work on small batch charges or on thin layers of ore, i.e. they produce small tonnage compared to the investment in equipment.

To allocate steel for the gas reformers, reduction furnaces and bricquetting presses, and to provide an excessive number of man-hours per ton to produce sponge and to feed this sponge to open-hearths and thus slow them down seems to be sabotaging instead of aiding steel production.

* * *

It would probably be more sensible to put the ores that could be contemplated for reduction to sponge, through idle gray iron cupolas revamped into little blast furnaces like those of 1825 and to blow the product in small converters into synthetic scrap than to go via the sponge iron route. Anyone would say that instead of doing this, the effort would be better spent in building another blast furnace and a few more ore boats to supply it, and work on regular ore, in regular, large scale production methods and end up with a product that the open-hearth can use without gumming up its operation. That's the route W.P.B. has chosen in the expansion so far.

With all the money spent by the Steel Corporation, Ford, and others in chasing the will o' the wisp of sponge iron *vs* the blast furnace in the past, and with that money written off as a loss, it seems pitiful that further huge losses of Government funds are imminent if the schemes for making scrap "by way of sponge iron" are carried through. It is to be hoped that W.P.B. will resist political pressure and crack-pot inventors. —H. W. G.

(Editorials continued on page 246)

Pressing one of the head sections.

Pressing Heavy Steel Shapes

by EDWIN F. CONE

Two features lend special interest to the heavy steel pressings whose manufacture is described in this article: The comparatively large size of the pieces pressed and therefore of the plate and presses used; and the peculiar suitability of some of the large flame-cut and pressed shapes for engineering service where only castings or forgings might at first blush seem feasible. The practice described is that of the Lukens Company, and the article covers press handling, die design, and product-service factors as affecting manufacturing methods.

IN THE LATE TWENTIES, when conditions in the steel plate industry were such that financial returns were not so favorable as those which had prevailed, and when there seemed little prospect of improvement in market conditions, Lukens Steel Co., Coatesville, Pa., one of America's largest producers of steel plate, looked about for new uses for its primary product.

One avenue which appeared promising was the production of pressed steel parts of many types for various applications. The early products Lukens thus formed were mostly pressed from plate less than 1/2 in. thick. Today the evolution of this development has resulted in special pressed shapes of products from 1/2 to over 6 in. thick.

Many of Lukens products are unique in design and application in various industrial equipment. Some of them are being substituted for both iron and steel castings. In general, finished plate, ferrous and non-ferrous, is sheared or flame-cut to specified shapes and then in hydraulic and mechanical presses with capacities up to 1,500 tons, is pressed hot into various products which are shipped to fabricators of the equipment of which they form a part.

Many problems are involved in these operations and it is the aim of this article to point out some of them and their solution and to describe the production of a few representative products.

Forming Large Head Sections

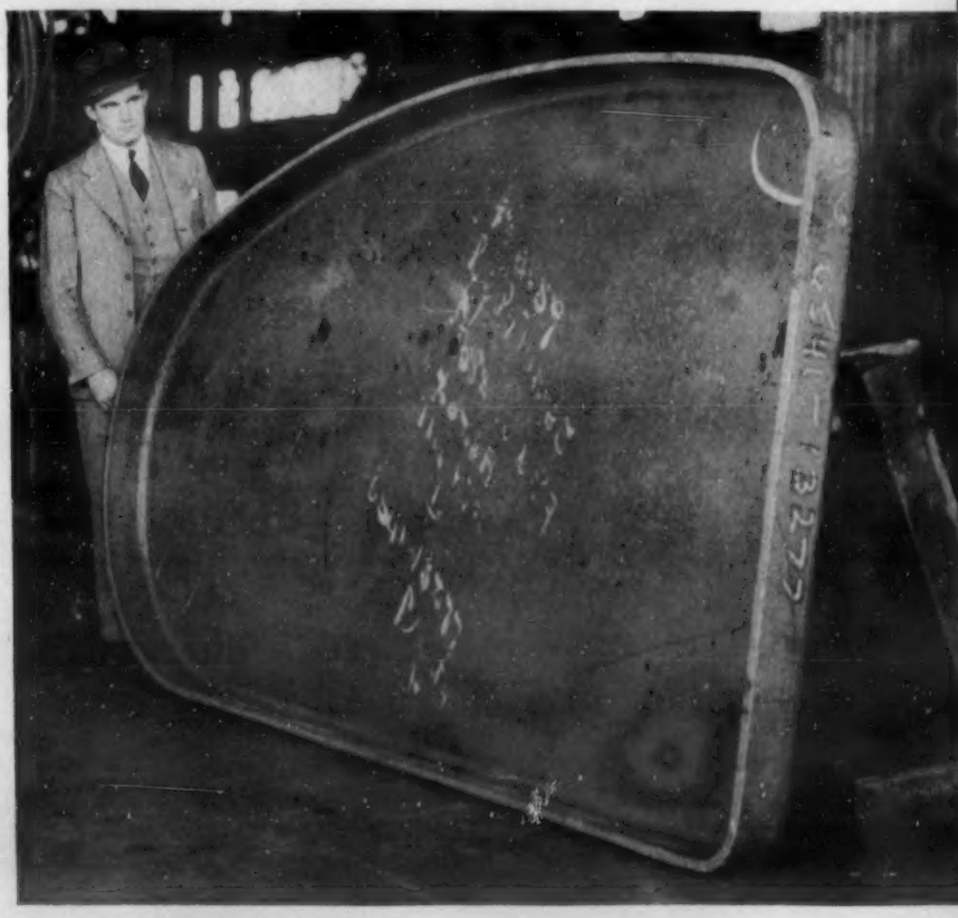
One of the most interesting, as well as one most difficult to produce is a head section referred to as a "bath tub end." From the angle of heavy pressing, these pieces presented more difficulties than any ever before attempted at Lukens.

Of an original order of 80 sections, 60 measured, in overall dimensions, 50 in. high, 59 in. wide, 22¾ in. deep and 3½ in. thick; 20 measured 47½ in. high, 59 in. wide, 22½ in. deep and 3½ in. thick, all formed with radii of 7½ in., 17 in. and 26 in. Each weighed about 4,300 lbs.

The die equipment necessary to press these pieces, when finally completed, weighed about 21 tons. After unsuccessful efforts to press them in a double section, it was decided to press them singly. Here a further difficulty arose. From the illustrations it can readily be seen that there would be an enormous thrust on the piece during pressing since one end was open and the other closed. To overcome this it was necessary to weld two heavy blocks to the flat plate prior to pressing. Two recesses were made in the male die to accommodate these blocks. This procedure counteracted the thrust. The flat circles of 3½ in. thick steel were heated to about 2,000 deg. F. The pressing temperature ranged from 1,800 to 2,000 deg. F. After the piece had been formed, it still carried a temperature of over 1,600 deg. F., which is safely above the critical range.

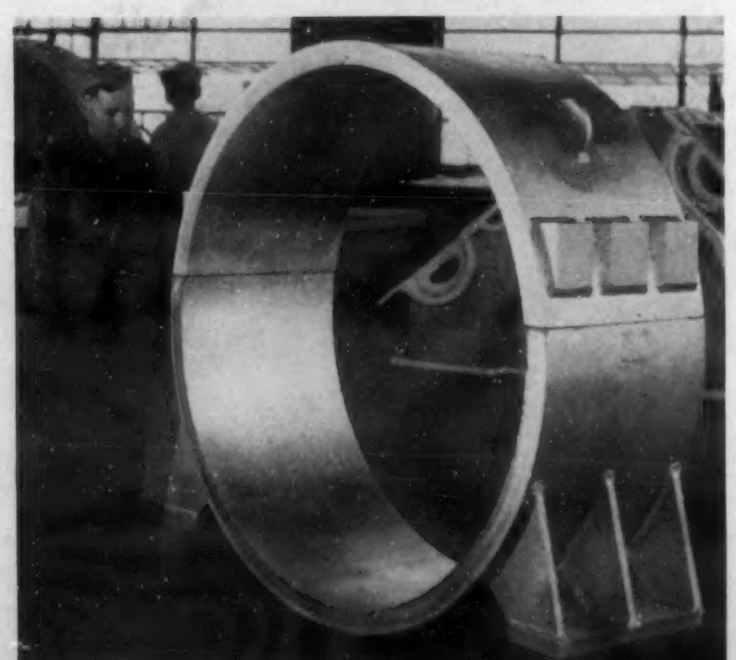
One of the finished pressed and flame-trimmed "bath tub" ends.

Center combustion chamber head.



One of the finished pressed Scotch marine boiler wing combustion chamber heads. It measures 8 ft. 7-3/32 in. long by 5 ft. 5/8 in. wide at widest part, 4 in. straight flange, 5-13/16 in. overall depth, 1 in. inside corner radius and 13/16 in. gage. A total of 272 of these, half right and half left, were hot pressed.

Die set-up for hot-pressing the head sections.



Welded pressed steel motor frame, fabricated in two sections. The ring is 5 ft. 6 in. high with a 25-in. face; it is 2⅞ in. thick. It weighs about 4,760 lbs.

After being pressed, these sections are flame-trimmed by By-Products Steel Corp., a division of Lukens.

Another interesting point is the peculiar die design required because of so many residual stresses set up in them during pressing. The main body of both the male and female die was made of gray cast iron. The ring had to be reinforced in addition to being bolted down to a heavy steel plate. All these reinforcing bars were cut from heavy gage plate, and added greatly to the overall weight of the completed dies. Several hundred head sections were made from them.

The intermediate section, to which the ends were welded, was rolled and scarfed by the fabricator. The fabricator requested that these pieces be uniform. All dimensions were held to a tolerance of minus zero inches, plus ⅜ in. These tolerances were necessary because the plate section was 3½ in. thick and if not held to close tolerance, innumerable fabricating delays would result.

Another view of the die set-up for hot pressing combustion chamber heads.

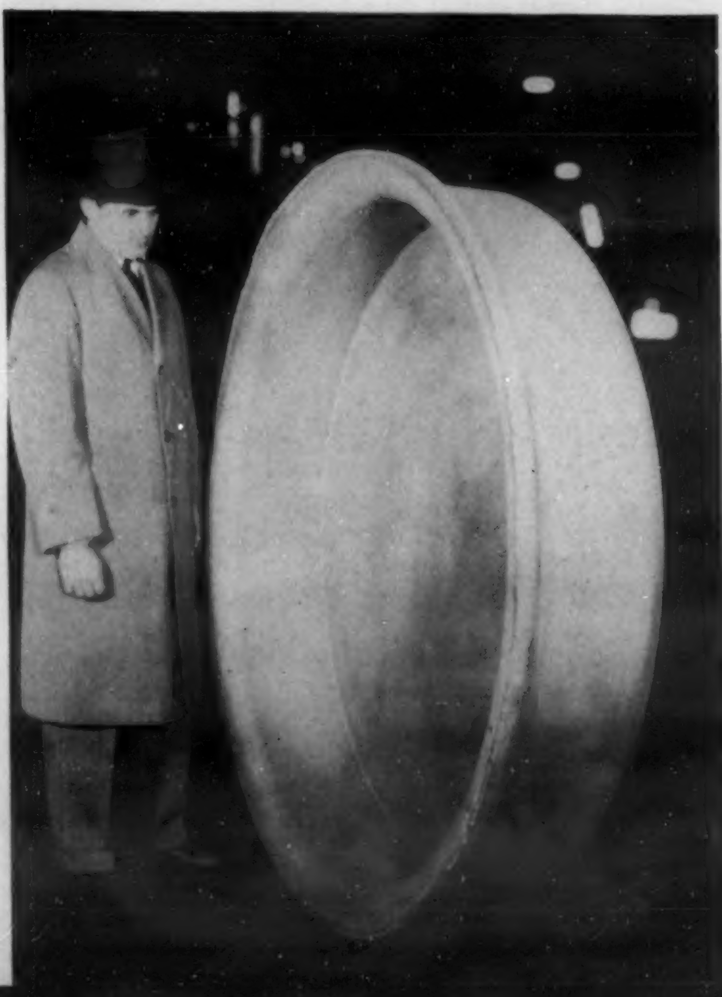
Ship Boiler Head Pieces

All Scotch marine boilers use internal combustion chambers requiring either 4 or 6 head pieces. The 4-head piece combustion chamber consists of a right front wing, a left front wing, a right back wing and a left back wing. The 6-head piece consists of right and left front wings, right and left back wings and front and back center heads. The right and left wing plates are kidney shaped and the center piece is designed to fit into the general contour between them. The illustrations show the die equipment necessary for pressing these plates.

Years ago, and even now, these heads were formed on an open side press by the old method known as sectional flanging, which consumes considerable time. It also causes quite a variation in the size of the finished piece because with this method it is difficult to form each piece with the same dimensions.

These head pieces for combustion chambers are pressed on a 1,000-ton press and the dies are so

One of 50 brake rims or drums hot pressed from a flat circle, 78¾ in. dia. and 1½ in. thick.



designed that all wearing surfaces can be machined. The pressed products are said to have a considerable advantage over those formed by the old method. All pieces measure the same, a distinct advantage; the flanges are more uniform; and the fabrication is much easier. These pieces are all pressed hot; therefore no residual strains are set up in the forming such as result when pieces are sectionally flanged.

Because of the great increase in activity in the shipbuilding industry, a tremendous number of these sections are needed. At present they are being produced by the hundreds. They are all developed in the flat, and gas cut to a pattern before pressing. A large number are fabricated by riveting but welding is being more and more adopted. The illustrations show various steps in producing these pieces.

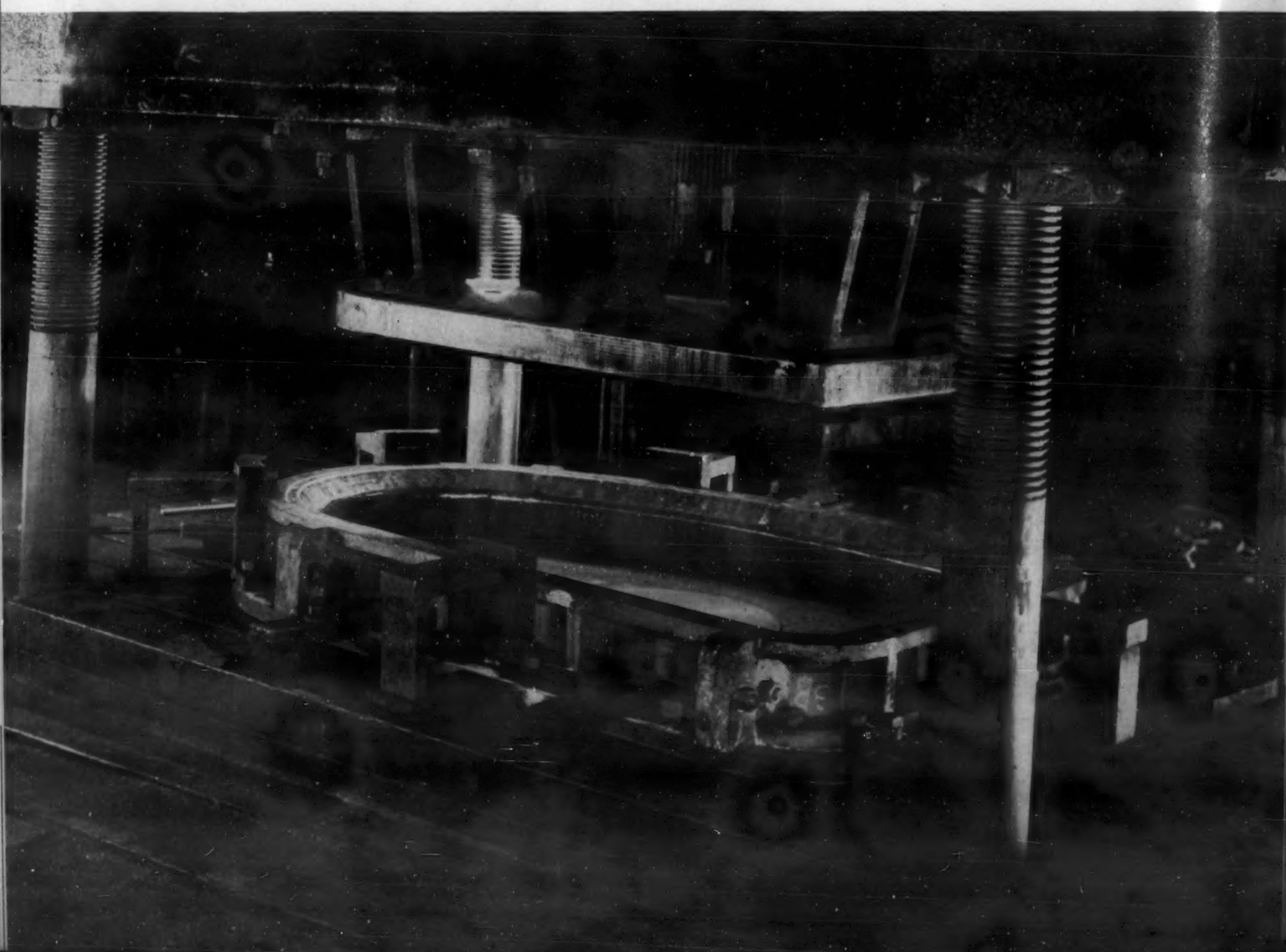
Large Brake Rims

Other pressed products of marked interest are large brake rims or drums of heavy gage steel. One of the illustrations shows the largest yet produced by the company. It is made of silicon killed steel of about 0.40 to 0.45 per cent C. The flat circle required for forming this brake drum was 78¾ in. diameter and 1½ in. thick. The completed brake rim measured 64½ in. outside diameter, 57⅝ in. inside diameter and 10⅜ in. overall depth. It weighs about 2,143 lbs.

Such brake rims are used on draw works for oil well drilling rigs. It is very important that the inside corner radius of the rim be as sharp as possible and that a relatively close tolerance on the outside corner radius at the bottom of the rim be maintained. Because of the heavy gage of the steel, this is quite difficult. Two separate and distinct sets of die equipment are required to complete the forming. In the first operation the dies are designed to draw as much material as possible without thinning the sidewalls of the drum and also leaving a sufficient amount of extra metal in the bottom to sharpen the thickness in the second operation. It is necessary to maintain all the thickness possible in the sidewalls which form the wearing surface of the brake drums that control the drop of the bit.

These drums are subjected to very rough treatment in the field. They often become so hot due to friction of the brake band that they must be cooled with

The die and press equipment for hot pressing the combustion chamber heads.



water. Sand and grit in the water tend to cut the braking surface of the drum and periodic machining is required.

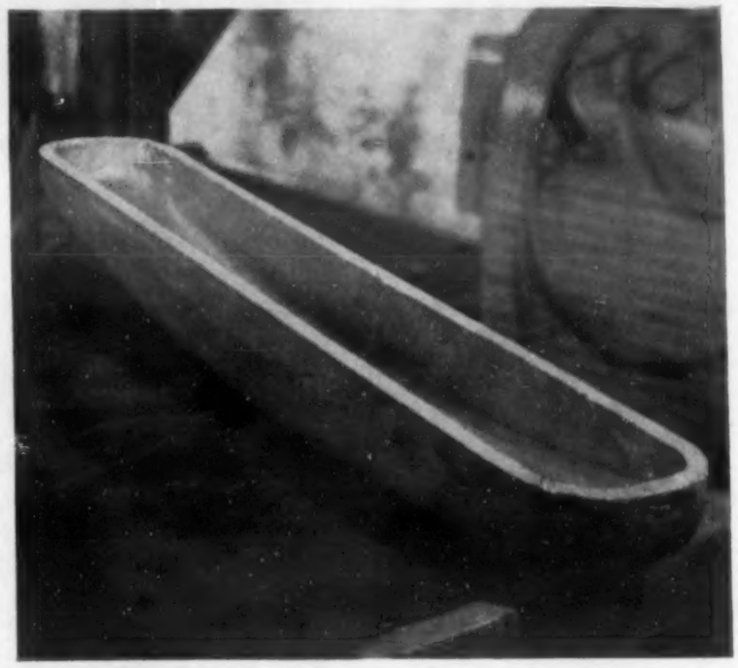
These are the only pressed steel brake rims in use today, it is believed. From 5 to 7 heatings and pressings are required to complete one, and the total 1,000-ton press capacity is needed to form them. Five types of drums are being produced, the difference in types being variations in diameters and gages, though all are formed to the same general shape.

Other Steel Pressings

Numerous other important products are made by Lukens of heavy gage steel pressings. Some of these, shown by illustrations, are dished heads of firebox steel, motor frames welded together, mooring bits, pipe pile points, elbow segments and bearing shells. Some of the lighter gage products are formed by By-Products Steel Corp.

In general, the grade of steel used is plain carbon though some low alloy steels are employed. Heat treatment of the finished product is usually unnecessary by the producer; if any is required, such as stress relieving, it is generally done by the fabricator.

One of 28 flanged and dished heads made of firebox steel. It weighs 353 lbs. and measures 5 ft. 4 in. long by 9¾ in. wide by 1 in. thick with a 16-in. radius of dish on the width and 144 in. radius of dish on the length, 1½ in. inside corner radius, 1¼ in. straight flange.



A variety of examples of sheared, blanked, pressedand bent products, formed by By-Products Steel Corp., a division of Lukens Steel Co.

The "Season Cracking" Test

by H. GISSER

Ordnance Laboratory, Frankford Arsenal, Philadelphia

The large quantity of ordnance materials, particularly cartridge cases, being manufactured and inspected makes it highly desirable to effect economies in reagents wherever possible. This is especially true in the case of the critical material mercury, sizeable amounts of which are consumed in making the mercurous nitrate test for "season cracking" of brass.

This article describes a procedure for replenishing mercurous nitrate solutions so as to salvage the large amount of residual mercury left after each test, and demonstrates that replenished solutions, within certain limits, are quite as effective in the test as the fresh reagent.

This article is published with the permission of the Chief of Ordnance. —*The Editors.*

THE USE OF MERCUROUS NITRATE solutions to detect excessive stresses in copper base alloys is almost universal. Until recently the mercurous nitrate solutions were used once and then discarded. Such a procedure required the use of large quantities of mercurous nitrate, as well as a great deal of labor to remove and destroy the spent solutions. In view of the large quantity of ordnance materials manufactured and inspected, it is desirable to effect an economy in material and labor required for inspection.

Preliminary tests have shown that from 40 to 80 per cent of the mercury remains in a solution which was originally 1 per cent mercurous nitrate, after the latter has been used to test cal. 0.30, 0.45 and 0.50 cartridge cases. When artillery cases are tested, the percentage of mercury remaining in solutions is still greater. Therefore, consideration was given to the possibility of replenishing spent solutions, provided it could be demonstrated that the presence of copper and zinc ions resulting from the initial test would not interfere with further tests.

Materials Used

Stock 10 per cent mercurous nitrate was prepared by dissolving 100 g. $HgNO_3.H_2O$ in a mixture of 500 ml. of distilled water and 100 ml. of c. p. nitric acid, sp. gr., 1.42, by gentle heating, and diluting the solution to 1000 ml. One per cent mercurous nitrate solution was prepared by diluting 100 ml. of the 10 per cent solution to 1000 ml. with distilled water. The 10 per cent mercurous nitrate solution was stored in contact with a small quantity of metallic mercury in order to maintain the mercury ions in the mercurous state.

All the reagents used in this work were c. p. Baker's analyzed grade. The following solutions are required for the mercury determination:

Potassium Permanganate 1%: Twenty grams of potassium permanganate were dissolved in 2 liters of distilled water. This solution was stored in an automatic dispensing burette for convenience.

Nitric Acid 1:1: One liter of nitric acid (sp.gr. 1.42) was poured slowly with constant stirring into 1 liter of distilled water. When cold, the solution was poured into an automatic dispensing burette.

N/01 Potassium Thiocyanate: Nineteen and four tenths grams of potassium thiocyanate were dissolved in 2 liters of distilled water.

The cal. 0.30 cartridge cases used in the mercury cracking tests were manufactured at Frankford Arsenal in 1938 by a five-draw process, but did not receive the low temperature stress-relief anneal. The cases were known to produce over 30 per cent external cracks, when tested in 1 per cent mercurous nitrate solution.

Checking the Mercury Content

The thiocyanate titration[1] was used to determine mercury in the spent solutions, and the procedure finally adopted was the following:

Fifty ml. of the spent solution, measured as accurately as possible in a 50 ml. graduate cylinder, were placed in a 300 ml. Erlenmeyer flask, and 10 ml. of 1:1 nitric acid added. One per cent potassium permanganate solution was slowly added with constant shaking, from a dispensing burette, until there was an excess, evidenced by the pink color of the solution which persisted 3 min., with or without the separation of brown manganese dioxide. Enough ferrous sulphate crystals were added, about ½ g., to destroy the excess permanganate and manganese dioxide, and

for Cartridge Brass—Saving Mercury

the solution was shaken until clear. The solution was then titrated with N/10 potassium thiocyanate until a reddish brown color appeared. The ferric sulphate formed by oxidation of the ferrous sulphate serves as indicator. The procedure was repeated with fresh 1 per cent mercurous nitrate solution. (This is necessary only when a fresh thiocyanate solution is prepared.) The entire determination can be run in between 5 and 10 min.

If R is the ratio of the volume of thiocyanate consumed to titrate the spent solution to the volume of thiocyanate used to titrate the fresh solution, then the value of X in the equation below represents the volume of 10 per cent mercurous nitrate solution in ml. to be added per liter of spent solution to bring the concentration of mercurous nitrate up to 1 per cent

$$X = (1 - R)\ 111.$$

For convenience a table of values of X corresponding to values of R was prepared (Table I).

Table I.—Values of X *corresponding to* R *in the equation $X = (1 - R)\ 111$.*

R	X	R	X
0.10	99.9	0.56	48.8
0.12	97.8	0.58	46.6
0.14	95.5	0.60	44.4
0.16	93.2	0.62	42.2
0.18	91.0	0.64	40.1
0.20	88.8	0.66	37.7
0.22	86.6	0.68	35.5
0.24	84.4	0.70	33.3
0.26	82.1	0.72	31.1
0.28	79.9	0.74	28.9
0.30	77.7	0.76	26.6
0.32	75.5	0.78	24.4
0.34	73.3	0.80	22.2
0.36	71.0	0.82	20.0
0.38	68.8	0.84	17.7
0.40	66.6	0.86	15.5
0.42	64.4	0.88	13.3
0.44	62.2	0.90	11.1
0.46	59.9	0.92	8.9
0.48	57.7	0.94	6.7
0.50	55.5	0.96	4.4
0.52	53.3	0.98	2.2
0.54	51.0	—	—

To ascertain the accuracy of the mercury determination for routine work, a series of these tests were run on spent and fresh solutions. In each case, the mercurous nitrate solution was carefully measured in a graduated cylinder. The results are given in Table II.

Mercury cracking tests were run in the routine manner. The cases were dipped for 30 secs. in nitric acid, 40 per cent by volume, washed in water, and then immersed for 15 mins. in 1 per cent mercurous nitrate solution which contained 1 per cent nitric acid (20 ml. for one cal. 0.30 cartridge case). The solution was then drained, the cases washed in running water, and the mercury volatilized on a hot plate. The cases were then examined for cracks with the aid of a microscope at 10x magnification.

To determine the effect of copper and zinc ions on the mercury test, two series of experiments were run. In the first series, sets of 50 unassembled cal. 0.30 cases were tested in 1 per cent mercurous nitrate solutions containing increasing concentrations of copper and zinc. After the test period, the solutions were drained off and titrated for fraction of mercury consumed. The data are given in Table III.

In the second series, 100 cal. 0.30 cartridge cases, known to produce over 30 per cent external cracks on testing in 1 per cent mercurous nitrate, were tested as follows:

Expt. No. 1: 25 cases in 500 ml., fresh 1 per cent mercurous nitrate solution;

Expt. No. 2: 25 cases in 500 ml. mercurous nitrate solution obtained by replenishing the spent solution from Expt. No. 1;

Table II

Vol. Spent Solution, ml.	Vol. KCNS (N/10) Av. of 5 Determinations, ml.	a. d. %
40.0	19.4	0.2
20.0	9.8	1.0
10.0	4.8	1.0
Vol. 1% $HgNO_3$ Solution, ml.		
40.0	39.2	0.2
20.0	19.7	0.3
10.0	9.8	0.2

Table III

50.0 ml. 1% $HgNO_3$ requires 43.0 ml. N/10 KCNS

Expt. No.	Solution Used (50.0 ml. in each expt.)	ml. KCNS	1-R (fraction of mercury consumed)
1.	Fresh 1% $HgNO_3$	15.5	0.64
2.	Fresh 1% $HgNO_3$ + 0.25% ea. $Cu(NO_3)_2$ and $Zn(NO_3)_2$	15.6	0.64
3.	Fresh 1% $HgNO_3$ + 0.5% ea. $Cu(NO_3)_2$ and $Zn(NO_3)_2$	19.2	0.55
4.	Fresh 1% $HgNO_3$ + 1.0% ea. $Cu(NO_3)_2$ and $Zn(NO_3)_2$	20.4	0.53
5.	Fresh 1% $HgNO_3$ + 2.5% ea. $Cu(NO_3)_2$ and $Zn(NO_3)_2$	16.8	0.61

Table IV

Expt. No.	No. of Cases Used	No. of Cases with External Cracks	No. of Cases with Internal Cracks
1.	25	9	17
2.	25	9	23
3.	25	11	20
4.	25	9	22

Expt. No. 3: 25 cases in 500 ml. mercurous nitrate solution obtained by replenishing the spent solution from Expt. No. 2;

Expt. No. 4: 25 cases in 500 ml. fresh 1 per cent mercurous nitrate containing 2.5 per cent each of $Cu(NO_3)_2$ and $Zn(NO_3)_2$.

The results of the examination for cracks are given in Table IV.

The replenishing procedure was used for a 4-week trial period in the mercury testing section of the Frankford Arsenal ordnance laboratory. Solutions were replenished five or six times before discarding. The limit was determined by the color of the solution, which became deep enough to interfere with the end point in the thiocyanate titration.

The economies effected are the following:

Total volume of fresh 1 per cent H_gNO_3 actually used (liters) 113.4
Total volume of 10 per cent H_gNO_3 solution for replenishing (liters) 11.53
Total mercurous nitrate salt used (kilograms) 2.287
Volume of 1 per cent H_gNO_3 solution used for tests (fresh and replenished, liters) 772.4
Mercurous nitrate salt equivalent to above (kilograms) 7.724
Mercurous nitrate saved (kilograms) 5.437
Volume of solution discarded (liters)
(a) Replenishing procedure 97.0
(b) If old procedure were used 772.0

Discussion of the Results

The tolerance in mercurous nitrate concentration in solutions for routine mercury testing is generally ± 5 per cent, *i.e.* 1 per cent ± 0.05 per cent. Reference to Table II shows that in routine replenishing, the mercury determination gives results accurate to better than 1 per cent of the mercury content. This determination is therefore perfectly satisfactory for routine replenishing of mercury solutions.

The variation of the results in Table III is to be expected since in routine tests, the solution is not agitated. The results indicate, semi-quantitatively, that the mercury consumed is independent of the presence of copper and zinc ions within the range of concentration studied. Table IV shows that the cracking effect of 1 per cent mercurous nitrate solutions is independent of the presence of copper and zinc, at least up to 2.5 per cent concentration of either $Cu(NO_3)_2$ or $Zn(NO_3)_2$ or both.

Rosenthal and Jamieson[2] have extended the procedure given in this paper to 10 per cent mercurous nitrate solutions and have shown that 10 per cent solutions may be replenished 12 times without affecting the test.

The work described in this paper was done in the summer of 1940, and since then the replenishing procedure has been in constant use in the mercury testing section of the Frankford Arsenal laboratory with substantial savings in material, labor, and time.

Conclusions

1. A procedure has been developed for the rapid determination of mercury in spent mercurous nitrate solutions. This determination can be run in 5 to 10 mins.

2. The amount of mercury deposited on brass cartridge cases from a 1 per cent mercurous nitrate solution and the cracking power of the solution is independent of the presence of copper and zinc ions up to at least 2.5 per cent of $Cu(NO_3)_2$ and of $Zn(NO_3)_2$.

3. A substantial saving in material, time, and labor can be effected by replenishing the spent mercurous nitrate solutions, used in mercury cracking tests.

Acknowledgment

The author wishes to express appreciation to E. R. Rechel of Frankford Arsenal for suggestions in conducting this work and to Sam Tour of Frankford Arsenal for advice in preparing this paper.

References

[1] W. F. Hillebrand and G. E. F. Lundell: "Applied Inorganic Analysis," John Wiley & Sons, Inc. New York, 1929, page 172.
[2] H. Rosenthal and A. L. Jamieson, "Mercury Cracking Test, Procedure and Control," *Proc. Am. Soc. Testing Materials,* Vol. 41, 1941, pages 897-904.

"Purging" Controlled Atmosphere Furnaces

by FRANKLIN B. LESLIE

Engineer, The Permutit Co., New York

Most engineers operating controlled atmosphere furnaces have the greatest respect for whatever explosion hazard is involved. It is thus common practice to "purge" a chamber of its air, before bringing it to a high temperature, by passing the combustible gas mixture through it until the gas/air ratio is above the explosive range. Actually, purging is ordinarily carried 'way beyond this point, since there is no accurate checking method in common use and it is better to be too safe than sorry.

The purging that is thus unwittingly continued after the danger of explosion has been passed represents a waste of time and of gases that is painful indeed under today's conditions. This article describes the operation and applications of an instrument that permits the quick and accurate checking of the extent of purging, thus reducing the explosion hazard as well as saving production time and materials. —*The Editors*

EVERYONE ASSOCIATED with the operation of pit or bell type furnaces (annealing covers) using controlled atmospheres rich in hydrogen and carbon monoxide recognizes the ever-attendant danger of explosion as a result of improper purging. Only after a serious accident do many of us understand how real this danger is.

Furnace builders and users alike have evolved operating procedures intended to overcome this hazard, the usual practice requiring that the furnace be purged for a specified period of time. The best laid plans can, however, go astray because of variations in size or location of charge or through such a simple oversight as a partly opened purge line valve or similar obstruction to free gas flow. The reduced gas flow may easily result in incomplete air removal and the formation of an explosive mixture of air and atmosphere gas.

It should be noted that, at the start of the purge, the furnace contents are not explosive because the concentration of combustible gases is below the lower explosive limit. As purging progresses, the lower explosive limit is reached and the hazard is present until the combustible gas content exceeds the higher explosive limit for the atmosphere gas being used.

In some instances tests for complete purging are made by attempting to ignite a small sample either collected or bled from the furnace outlet. Smooth combustion of this sample is taken to indicate a sufficiently complete purge. To the best of the author's knowledge instruments have not been used to any extent in establishing safe conditions. However, many engineers are giving increasing attention to gas analysis equipment in this connection, and it is likely that others will be interested in knowing of recent developments.

The Explosion Gases and Their Densities

The dangerous constituents in commercial atmospheres are hydrogen, carbon monoxide and methane, the latter as a rule being present in low concentration. The remaining gases are usually carbon dioxide and nitrogen which, being inert, act as diluents or "buffers." By inspecting the data in Table I, it will be noted that the specific gravity of the explosive gases is less than 1.0 (air).

Table I.—Specific Gravities of Individual Components of Controlled Atmospheres

Constituent	*Specific Gravity (Air = 1.000)*
Carbon dioxide	1.527
Nitrogen, argon, etc.	0.972
Carbon monoxide	0.968
Methane	0.554
Hydrogen	0.069
Ammonia	0.595

Table II.—Specific Gravities of Typical Controlled Atmospheres

Atmosphere Type	Composition, per cent CO_2	CO	H_2	CH_4	N_2	Specific Gravity
Incomplete combustion	6.0	9.6	10.3	0.5	73.6	0.913
Incomplete combustion + secondary cracking	2.0	16.2	23.8	0.7	57.3	0.765
Catalytic cracking	1.1	18.2	34.6	0.6	45.5	0.663
Dissociated NH_3	..	..	75.0	..	25.0	0.294
30% Dissociated NH_3	..	..	22.5	70.0 NH_3	7.5	0.504

When the controlled atmosphere contains sufficient combustible gases to impart explosive possibilities, it will also be found that their presence causes the overall specific gravity of the atmosphere to be less than 1.0. To illustrate this statement consider the typical atmospheres given in Table II.

Any number of other analyses might be listed, but it is evident that since the relative density of air and the atmosphere gas differ, it is possible to measure the proportions of air in the furnace gases by comparing the specific gravity of the outlet mixture with the specific gravity of the atmosphere gas entering the furnace.

As an example, if an atmosphere gas of 0.80 specific gravity is admitted to a furnace and the specific gravity of the outlet gases is 0.90 it may be concluded that the mixture is half air and half atmosphere gas but, if the specific gravity of the outlet gas was measured and found to be 0.80, the gas no longer contains air and the furnace has been completely purged.

Some furnaces are "double purged," first with an inert gas and subsequently with the controlled atmosphere gas, the purpose being to remove all oxygen before introducing combustible gases. The inert gases commonly prepared by burning fuel gas with the theoretical air supply, thereby producing a CO_2 N_2 mixture, the specific gravity of which is above 1.0. The specific gravity of the outlet mixture may be used to indicate when complete air removal has been effected and it may also be used on the second purge to indicate when the controlled atmosphere has completely removed the inert purging gas.

Safe Purging

One method of testing for safe purging therefore resolves itself into measuring the specific gravity of the outlet gases and continuing the purge until the specific gravity of the pure atmosphere gas is reached (or very nearly reached).

To illustrate how purging progresses, the curve shown in Fig. 1 was prepared from data obtained on an electrically heated Bell furnace. Before using the specific gravity measurement as a check on operation, the standard practice had been to purge this furnace for an hour and a half. Some portion of this period was provided to allow for uncertainties. However, it will be observed from the chart that when using the specific gravity to "analyze" the furnace gases, the purging time could be reduced to 40 min. because in that time the purge has become sufficiently complete. Nearly an hour of valuable time can thus be safely saved on each heat.

It should not be misunderstood that the minimum safe purging time can be determined once and then repeated as a standard rule but rather that the specific gravity should be measured during every purge. The operator will then know on every heat when complete purging has been effected and thus accomplish the time saving without risk of explosion.

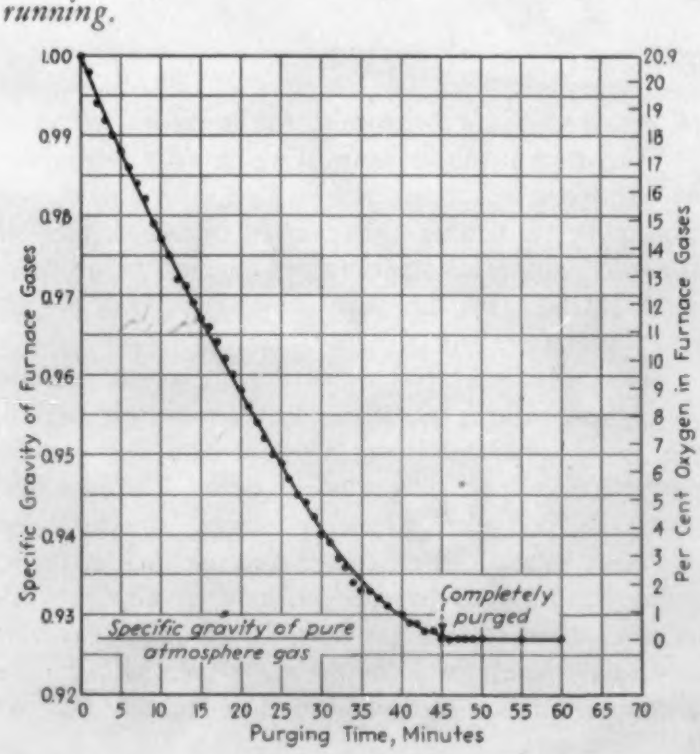
In many cases small amounts of air remaining in the furnace may interfere with the heat treatment even though there might be no danger of explosion. When the specific gravity of the outlet gases is measured it is readily possible to detect when all the air has been removed so that the heat treatment is not started until correct conditions prevail, thereby protecting the quality of the work.

Measuring Atmosphere "Quality"

In addition to safety, which is of paramount importance, the measurement of specific gravity may be used in the preparation of the atmosphere gas to assist in maintaining uniform composition, thereby improving the quality of the product being heat-treated.

The meaning of specific gravity when applied on some of the popular atmospheres either for determining safe purging or checking atmosphere uni-

Fig. 1. Purging curve: Electrically heated Bell furnace. Charge: 13,500 lbs. of coiled strip steel. Fan running.



formity in production, is described in the following paragraphs.

"Incomplete Combustion" Atmospheres: When a fuel gas is burned with less air than is needed for complete combustion, the resulting atmosphere usually contains carbon dioxide, carbon monoxide, methane, hydrogen and nitrogen. The analysis depends on many factors but mostly upon the air/gas ratio. When this ratio is relatively high, the gas contains a large percentage of carbon dioxide and small amounts of carbon monoxide, methane and hydrogen. The gas has a comparatively high specific gravity because of the high carbon dioxide content. With lower air/gas ratios the carbon dioxide decreases and the carbon monoxide, methane and hydrogen increase and, under these conditions, the specific gravity is lower because of the increased hydrogen content. It is therefore possible to maintain the correct ratio by measuring the specific gravity of the combustion products. Variations in specific gravity and composition of the raw gas, variations in humidity of gas or air and variations in temperature or pressure of gas or air may thus be compensated for by adjusting the combustion equipment to produce an atmosphere of constant specific gravity. Variations of 0.1-0.2 per cent carbon dioxide and even smaller variations of carbon monoxide and hydrogen may be readily detected by the specific gravity measurement.

Fig. 2. The relation between the composition and specific gravity of the atmosphere of a normalizing furnace operating on West Virginia natural gas.

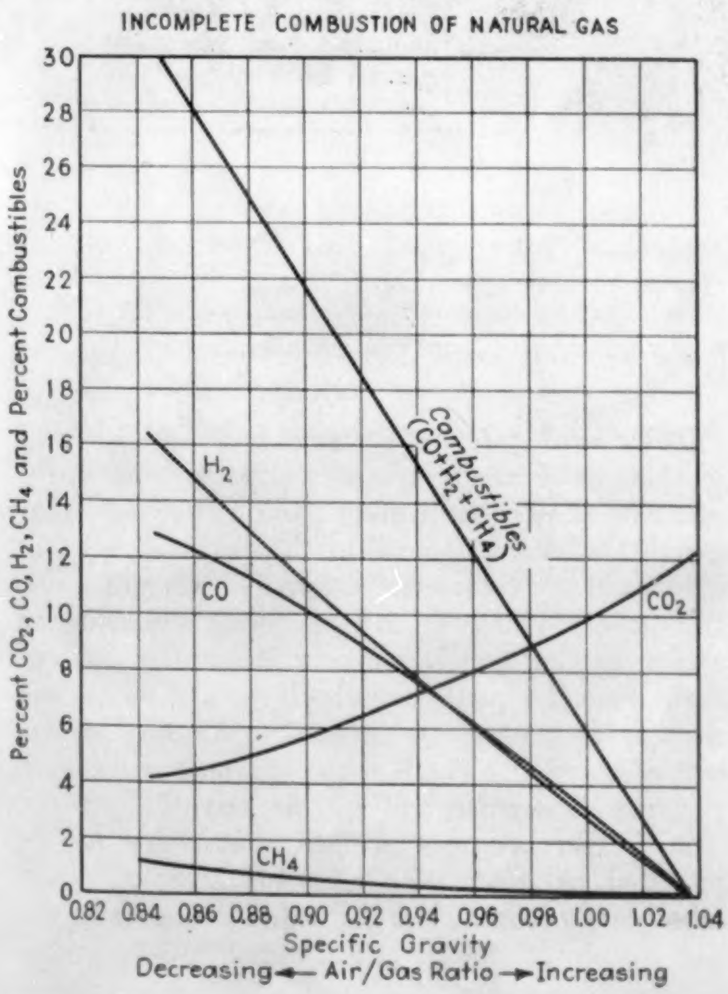


Fig. 2 shows the relation between the composition and specific gravity of the atmosphere of a normalizing furnace operating on West Virginia natural gas. This chart shows the reason why measurement of the specific gravity gives the necessary information on the analyses of the atmosphere gas. It is not necessary however to prepare such a chart because with only little experience the operators will learn that a particular specific gravity corresponds to the desired atmosphere composition and it then becomes a simple matter to hold the analysis constant or reproduce it at any time.

Incomplete Combustion With Carbon Dioxide Removal: Some atmospheres are produced by incomplete combustion followed by removal of the carbon dioxide through chemical absorption or converting carbon dioxide to carbon monoxide by passing the gas through incandescent charcoal. By sampling the generator gas, the air/gas ratio may be verified and by sampling the finished gas, the completeness of carbon dioxide removal or conversion may be investigated.

Unburned Air-Gas Mixtures: At times it is desirable or necessary to measure the air/gas ratio before combustion and this may be done by measuring the specific gravity of the unburned mixture. For example, the correct specific gravity when $3\frac{1}{2}$ parts of air are mixed with one part of gas of 0.64 specific gravity is calculated to be 0.92 as follows:

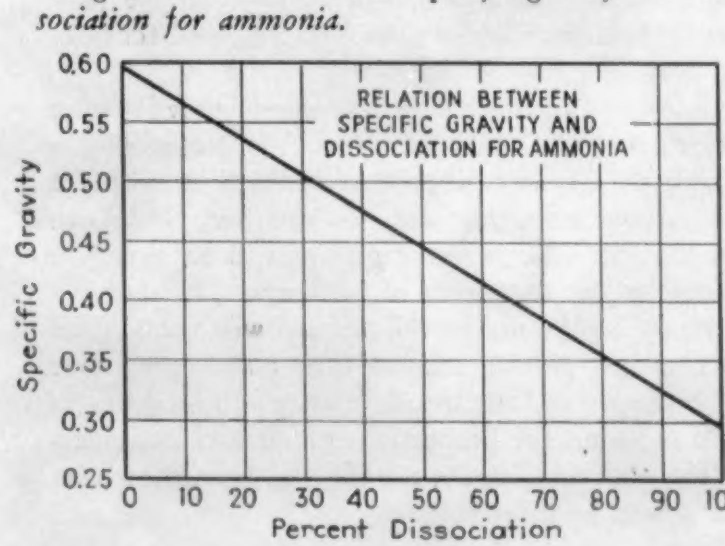
Gas	—	1 part	$\times$ 0.64 =	0.64
Air	—	$3\frac{1}{2}$ parts	$\times$ 1.00 =	3.50
Mixture	—	$4\frac{1}{2}$ parts		4.14

$$\text{Sp. gr.} = \frac{4.14}{4.50} = 0.92$$

A higher ratio will be indicated by an increase in specific gravity and conversely, a lower ratio by a decrease in specific gravity.

This same principle may be applied in proportioning fuel gases of different specific gravity, as for ex-

Fig. 3. Relation between specific gravity and dissociation for ammonia.



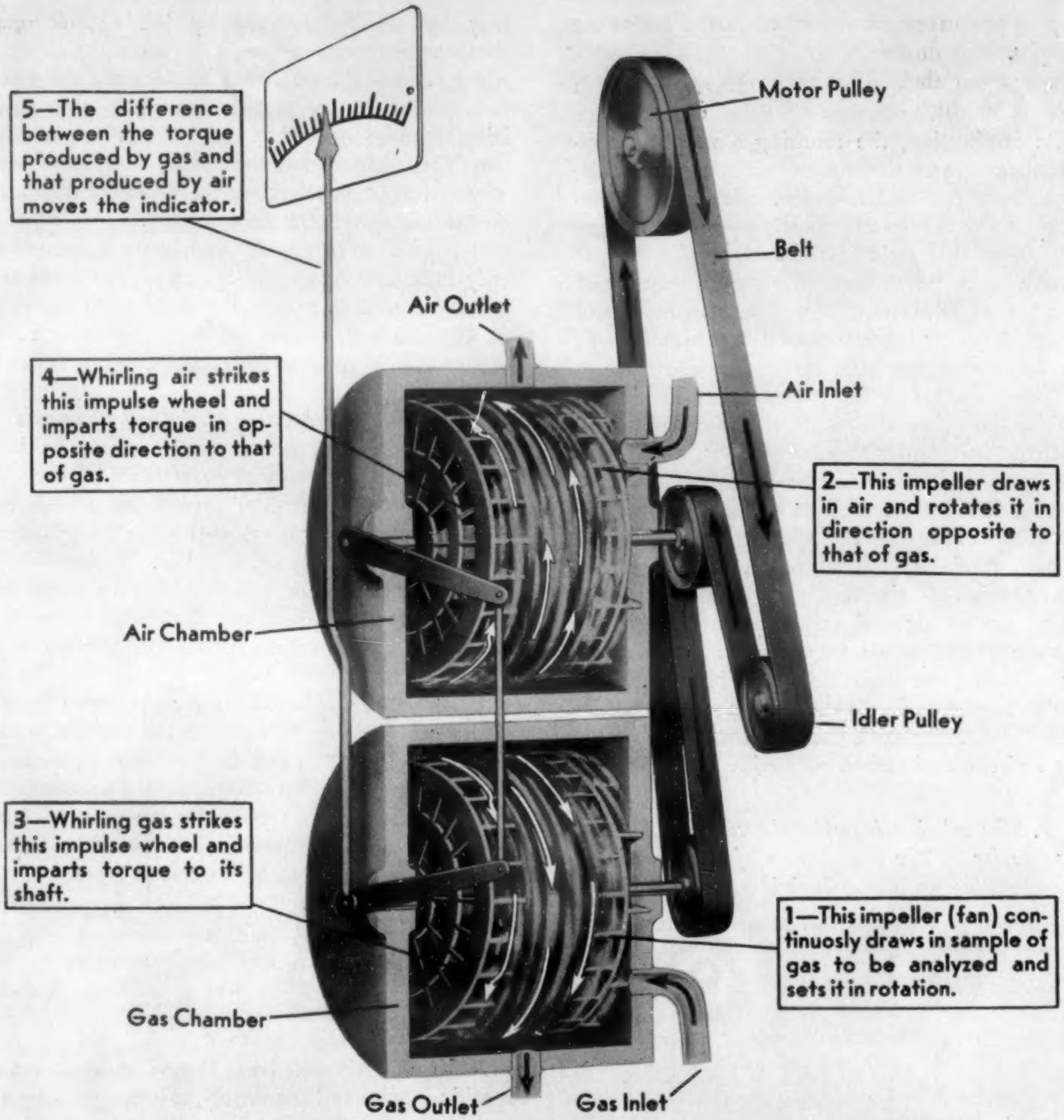


Fig. 4. A simple automatic instrument for measuring the specific gravity of gases shown in phantom. Follow the 5 points for an explanation of the principle of operation.

ample natural gas and coke oven gas. In the same manner butane-air and similar mixtures, used for heating purposes, may be controlled.

Catalytic Cracking: When a gas is burned with a very marked deficiency of air, in the presence of a catalyst the atmosphere produced is rich in hydrogen and carbon monoxide and contains very little carbon dioxide. The specific gravity will be very low because of the abundance of hydrogen. If improper operating conditions prevail the gas will contain too much carbon dioxide and too little carbon monoxide and hydrogen and the specific gravity will increase.

To ascertain the proportions of air and gas entering the cracking unit, the specific gravity of their mixture should be measured.

Dissociated Ammonia: If ammonia vapor is heated to about 1600 deg. F. it cracks to produce an atmosphere of 75 per cent hydrogen and 25 per cent nitrogen. The raw ammonia has a specific gravity of 0.595 and the completely dissociated mixture a specific gravity of 0.295. It is therefore apparent that a high specific gravity indicates incomplete dissociation. Should a partly dissociated mixture be desired, the specific gravity may be used to measure the extent of cracking. Fig. 3 shows the relation between per cent dissociation and specific gravity.

A cheaper hydrogen-nitrogen atmosphere may be produced by dissociating ammonia completely and subsequently burning the gas with a deficiency of air. The oxygen of the air burns with the hydrogen to

produce water vapor which is removed and the nitrogen serves to dilute the gas. Depending on the desired dilution there will be an optimum specific gravity value which should be maintained.

Improving Economy

Another important use for specific gravity measurement concerns fuel economy in gas heated furnaces such as those using radiant tubes. The combustion is carried out with an excess of air and the combustion products contain carbon dioxide, oxygen and nitrogen. When too much air is supplied a large amount of heat is wasted in the large volume of flue gases which leave at relatively high temperature. At the same time the carbon dioxide is low because of dilution by the excess air. As the air supply is reduced the heat loss diminishes and the carbon dioxide increases. The specific gravity gradually increases until it reaches a maximum with the theoretically correct air supply. Should the air supply become deficient free hydrogen will appear in the combustion gases and cause a sharp drop in the specific gravity. Thus to obtain maximum combustion efficiency it is only necessary to adjust the burners to produce flue gases of the highest specific gravity.

The Measuring Instrument

A simple automatic instrument for measuring the specific gravity of gases is shown in phantom in Fig. 4 and is known commercially as the Ranarex furnace atmosphere analyzer. The action is quite similar to the "fluid drive" except that the fluids are gases instead of oil.

The lower impeller (fan) draws in a sample of the gas being tested, sets it in rotation and creates a torque on its companion impulse wheel located in the same chamber. This torque, which is proportional to the gas density, is compared with the torque produced by atmospheric air in an identical upper chamber, the impeller of which rotates in the opposite direction. The difference between these opposing torques is a measure of the specific gravity and causes the pointer to move over the scale. The gas sample and air are brought to the same temperature and humidity by a humidifier, eliminating possibility of error from those sources. A steel wool filter removes suspended matter and corrosive constituents from the gas, should they be present.

The gas sample passes continuously through the instrument at a high rate of flow and since no time is required for chemical reaction, the instrument responds almost instantaneously. The essential parts consist of a motor, drive belt, bearings, fans and a mechanical indicator which are readily understood by the average operator.

Applications

An aircraft parts manufacturer uses a stationary type of this instrument rather uniquely on a pit type normalizing furnace. The instrument is piped to sample either atmosphere gas at the generator or outlet gas from the furnace. Before the purge is started a reading is taken on the atmosphere gas at the generator outlet and, if the gas does not have the desired quality, the necessary adjustments are made before purging. The apparatus is then switched to sample furnace outlet gas and when the gas conditions become safe an electrical contact mechanism within the instrument automatically turns on the heating elements.

In addition to safety and knowledge of the atmosphere quality, this user derived another benefit in discovering a leak in a stuffing gland of a gas recirculating pump used during the cooling phase. This leak had previously admitted sufficient air during the cooling to discolor the charge although the furnace temperature was below the ignition temperature and there was no explosive hazard.

A producer of steel strip annealed in bell type furnaces, uses the portable model, moving it to whichever base and cover are being purged. A total of 18 bases are installed in this plant and the quality of the atmosphere gas produced at the generators is continuously indicated and recorded on a stationary type of instrument.

Successful applications of specific gravity measurement have been made in heat treating iron, steel, copper, brass, nickel, silver and gold. Specific gravity measuring instruments are useful in preventing serious accidents involving human injury or loss of life, loss of production time and the expense of damaged furnace equipment. Other important features are that specific gravity provides a guide for maintaining high combustion efficiency and uniform quality of furnace atmosphere resulting in uniform heat treatment.

(Editorial, continued from page 231)

Heat Treating, Past and Future

One of the developments which will ensue, as a result of research and experimentation during the war, will be our increased knowledge of the fundamental principles of heat treating and what can be accomplished by their proper and broader use.

Previous to the war we had made great progress in the application of heat treatment, and the development of equipment, to alloy and also to plain carbon steels. Witness, for example, the introduction of controlled atmospheres in its many phases.

But the critical situation in alloying elements, resulting in the recasting of many of our alloy steels and in some modifications in our plain carbon steels, has presented new problems in heat treating. For example, take the case of wrought armor plate. With the lowering of the chromium and nickel content and perhaps the addition of other elements, changes in the heat-treating cycle have resulted in no deterioration and some improvement in ballistic and physical properties.

And in making cast steel armor plate many things have been learned which did not seem plausible earlier—this grade of munition material can now be made to meet severe ballistic specifications by careful and special methods of heat treatment with very little, if any, nickel or chromium present.

Even carbon steels, though now modified in composition, particularly as regards manganese, are at present rendered even higher in physical quality by improvements in the heat-treating technique.

And in the non-ferrous field improvements in technique and in the effects obtained are also the result of developments forced by the war.

We entered the Emergency and the War with certain preconceived ideas as to just what could be accomplished by heat treatment. We shall emerge from the crisis with decidedly altered ideas as to just what heat treatment can accomplish in handling the simpler alloy and carbon steels with no sacrifice and perhaps some improvement in quality and properties.

Certainly the science of heat treating is making and has made important advances.

—E. F. C.

A LETTER TO THE EDITOR

Enamelware Utensils in the Services

To the Editor: On page 768 of May, 1942, METALS AND ALLOYS, we note a statement relative to the effect of chipped porcelain enameled products as follows:

> Enamelware is impractical for the rough, hard service it would receive in the field kitchens and ship galleys. Chipping of the enamel would occur and expose the steel under the surface to corrosive action. Besides this some foods may not be cooked in enameled utensils because of the chemical action occurring between the food and enamel. Finally, the enamel specified by the Navy is composed, among other things, of scarce tin, cobalt and antimony.

It will probably be of interest to you that approximately 100,000,000 pieces of porcelain enamel kitchen ware are produced in this country each year. Apparently no serious effect to the health of the Nation results from the use ot these utensils.

Reference to a news release of June 9, 1942, issued by the Division of Industry Operations, War Production Board, regarding Amendment No. 1 to Conservation Order No. M-39-b, shows that no cobalt, as such is permitted to be used in porcelain enamels. The only material which can be used is a cobalt-nickel oxide which is a very cheap product occurring in large quantities in Canada and of which there are unlimited supplies. Tin has not been used extensively in the wet process enamel ware field for years as its high price has forced it out of this market. Zirconium has largely replaced tin in this field. As to antimony, it is now used only in very small quantities.

Porcelain Enamel Institute
Washington, D. C.

C. S. PEARCE
Managing Director

EFFICIENT INDUSTRIAL SALVAGE

— AN ENGINEERING PROBLEM

by Fred P. Peters
Managing Editor

The broad purpose of "conservation" should be simply to get the maximum of war products out of our actual total material-supply. A sound conservation effort, therefore, — whether nation-wide or in an individual plant — not only tries to "stretch" the available critical metals by using a smaller amount of them per product manufactured, but also seeks to add to the raw-material pile by utilizing to the fullest every pound of metal that can be found.

This article attempts to provide for engineers in the metal industries specific information and suggestions on how to conserve metals in design and production, how to reclaim worn and broken parts, how to keep their scrap volume at a minimum, and how to operate so that whatever scrap their shops do produce can be ultimately squeezed of its last drop of useful metal value.

In Washington, the War Production Board unit established for these combined purposes on a nation-wide scale is the Bureau of Industrial Conservation, whose chief is Lessing J. Rosenwald and deputy chief Paul C. Cabot. The *Industrial Salvage Section* of the Bureau, now headed by Hamilton W. Wright, is charged with the responsibility for organizing and propagandizing the type of salvage operations discussed in these pages.

The Industrial Salvage section is following a 3-way program, through direct contact with manufacturers, to (1) unearth every piece of idle or obsolescent metal (machines, tools, dies, jigs, etc.) and add it to the "available" scrap pile; (2) reduce waste and spoilage to a minimum, foster the use of practices to extend the life of metal parts or tools that might normally be discarded, and encourage the direct utilization of blanks, short ends and clippings; and (3) establish efficient methods of handling and reclaiming the unavoidable scrap in production and fabricating operations.

Engineering action is required to solve the problems with the directness and dispatch that are imperative. Here, then, are some of the specific engineering practices that individual metal-industries plants should consider and adopt (where feasible) to make their metal-supply and that of the nation go just so much farther.

Designing to Lessen Scrap

An efficient scrap reduction program properly begins with the metallurgical design engineer — the man who stipulates materials, metal-forms and fabricating operations when the product is in the design stage. In munitions and war-production-machine design, the No. 1 consideration must always be the safe and effective performance of the finished part, but where a choice is available to the engineer he should:

(1) Specify materials with a minimum tendency to produce scrap — *i.e.* those that are easiest to work and which experience shows meet specifications with the highest "yields" in a given series of operations.

(2) Select fabricating operations that involve little or no waste-metal in forming; avoid, if possible, process-designs that require removal of much metal by machining. Don't, for example, bore out a hollow cylinder when tubing can be used or when the hole can be cored in a casting operation. Study the list of processes that can turn out a part of not-too-complex design approximately in final form, without requiring much subsequent machining — die casting, permanent mold casting, powder metallurgy, cold heading, drop forging, etc.

(3) If possible, order parts in finished form, if their manufacture necessarily involves waste metal — it is better, from the National scrap-utilization viewpoint, for aluminum stampings to be made by a shop specializing in such work than by one that handles all types of metals and forms, since the stamping scrap is less likely to become mixed or contaminated in the specialty shop than in a general manufacturing plant. Similarly, it is better for a small shop to buy brass screw-machine parts from a brass company, who can immediately and fully utilize the turnings, than to buy bar stock and turn the parts itself.

(4) Watch the "geometry" of part design — particularly sheet metal work — to be sure that the maximum number of parts is produced from a given piece of metal with the minimum amount of scrap. Punchings or blankings should be so positioned as to leave the absolute minimum of unused metal between them and along the edges. Sheet steel widths should be purchased to conform to this philosophy, too.

(5) Study possible design modifications that will permit the use of residual blanked squares, rectangles, circles or unavoidably large irregular shapes, left after a regular stamping operation in direct production. Sometimes they may serve for templates, or can be bent, formed, welded or brazed into some other small part. Short ends or croppings can also often be further fabricated into useful parts.

(6) Specify general quality and precision no greater than is necessary for actual service requirements. Dimensional tolerances that are too narrow or mechanical specifications that are unnecessarily stringent result in scrap through excessive rejections on inspection.

(7) Design to employ standard parts and tools wherever possible, and thus avoid grinding, machining or slitting to special sizes.

But above all, remember that metal-design practice can be just as important as metal-processing in reducing or avoiding scrap.

Avoiding Waste in Production

The first and most obvious rule for

In these "tea kettle" gas-fired furnaces metals reclaimed from scrap from Westinghouse machine and other shops are melted at the Linhart works, producing 20 tons of ingots per day.

reducing *production* scrap is to avoid mistakes and poor workmanship leading to excessive off-quality rejections. This implies the best of engineering, process control and departmental inspection throughout the manufacturing operations.

It follows from this that the inspection department can be the "salvage engineer's" detective in uprooting bad sources of scrap. Persistent part rejections because of the same condition should lead to immediate investigation of the technical practice or sloppy workmanship that may be causing it.

Production equipment that is defective or improperly designed may often be the root of the trouble, and thorough equipment-maintenance practice is, therefore, essential to a production-scrap reduction program (as it is, of course, to a campaign to keep the equipment itself out of the scrap pile). Jigs or fixtures that wear or shift out of alignment; furnaces that heat the charge unevenly because of shell-warping, refractory-spalling, dirty burners or inaccurate thermocouples; melting crucibles that are improperly dried or aged; and faulty machine-tool or forming press lubricating systems that provide insufficient, improperly directed or irregularly-flowing coolant or lubricant are only a few of many possible equipment conditions that can lead directly to excessive rejections.

Bad practice, too, can be a painfully prolific source of scrap. Sometimes the mistakes are simply localized carelessness, while in other instances scrap accepted as "unavoidable" is actually the result of unenlightened technical practice and could be sharply reduced through intelligent engineering attention.

In the "mistake" class belong such unfortunate incidents as improper grinding of cutting tools, with consequent tip-cracking; over-heating of high speed steel tools; "burning" of forging stock in the furnace; cracking of parts or tools through hasty heating or the use of the wrong quenching medium or cycle; inadvertent use of a "reducing" atmosphere when heating certain plain carbon or low-alloy tool steels with consequent irremediable soft skin; over-pickling; and many others.

Scrap-making Practices

Of course, any of the foregoing may be "normal practice" in a particular shop, rather than localized mistakes, and if such is suspected to be the case, some engineer should immediately be assigned to determine the *right* way of doing the job. There are, however, a few general processing practices that are the cause of excessive production scrap but which are ordinarily tolerated for one reason or another.

Many mills, for example, in their zeal to remove all ingot pipe, have cut off more of the ingot head as a regular practice than is actually necessary. Even an inch more of useful metal left with each ingot can add up to tons of "immediately salvaged" metal in a year. And beyond that, the supervising engineer or metallurgist should be certain that his mold practice and hot-topping are such as to keep the amount of pipe at an absolute minimum.

Similarly, billet, bar- and rod-ends and similar cuttings should not be carelessly made — no more of the end than is actually mutilated should be sheared or cut.

In the foundry, much can be done to reduce the spread between charge-weight and amount of good, finished castings. The practice of running off an excessive amount of cupola iron before the metal is hot enough for the molds is an especially serious metal-waster. The proportion of low-temperature metal in a stack can be reduced by building a good high bed in the cupola and holding the charge until the wood is all burnt out. Many gating practices are wasteful, too, since they are often designed to feed the casting at a time when feeding is actually impossible.

Wherever possible (and sensible) heat treating practices that lead to metal waste by necessitating either subsequent pickling to remove scale or grinding to remove decarburization should be modernized. Particularly where production is fairly stabilized as to the nature of the steel, the installation of controlled atmosphere equipment is relatively simple and satisfactory, from the standpoint of producing work free of scale and decarburization.

In the same way, everything possible should be done so that only the minimum allowance need be left for correcting distortion after heat treatment. This is particularly important at present, when high-alloy, low-distorting steels are frequently being replaced by low-alloy or plain-carbon steels that depend on relatively drastic quenches for full development of their properties. Surface hardening (flame or induction) of parts, the use of distortion-minimizing kinks for tools and dies (such as those described on pages 777 and 778 of METALS AND ALLOYS for May) and the employment of *uniform* heating methods (such as modern electric salt bath systems or convected air furnaces) where through-heating is necessary are often helpful in eliminating excessive distortion.

Press forming and drawing should be carefully planned, so that the metal is not worked too drastically. Overworking can lead to cracks that may be blamed on annealing or heat treating

SHOP RECLAMATION METHODS

Reclamation Method	Typical Applications	General Remarks	Sources of Detailed Information
FUSION WELDING	Repairing cracked castings—all metals. Filling blowholes and porosity. Joining broken sheet metal work. General repair of parts, tools and structural components.	Involves actual fusion of the base metal, and use of a similar filler rod. Good for severe service. Pre-chipping and often pre-heating are necessary, and part may have to be stress-relieved. Very versatile, but cannot be used freely on tool steels. Gas, arc and thermit methods are all used.	Arc-welder manufacturers[1] Gas-welding equipment manufacturers[2] Welding rod producers[3] Metal and Thermit Co. (thermit)
BUILD-UP WELDING	Increasing the O.D. of shafts worn or machined undersize. Repairing bores machined or worn oversize. Building-up threads, sprockets, gear teeth, track ends, journals, etc. Applicable to most metals—especially steels.	Permits restoring part to desired size, using material of similar composition and properties. Requires preheating; often involves distortion. Deposited metal can have high strength and hardness.	Arc-welder manufacturers[1] Gas-welding equipment manufacturers[2] Weld-rod producers[3]
BRONZE-WELDING	Repairing cracked or broken cast iron and steel parts, or other metals with m.p. higher than bronze. Building-up wearing surfaces on shafts, bearings, bushings, rings, valves, etc.	Not "fusion welding." High-zinc bronze filler metal used has lower melting point than base metal. Distortion is thus low. Process is fast, ordinarily uses torch heating. Joints are strong—sometimes stronger than parent metal.	Brass and bronze producers[4] Gas-welding equipment manufacturers[2] Weld-rod producers[3]
LOW-TEMPERATURE WELDING	Repairing all types of broken tools. Making composite and extension tools. Building-up broken gear teeth, etc. Applied to all common ferrous and nonferrous metals.	Employs filler-metal and flux specially designed for each metal being welded; welding temperature is lower than m.p. of parent metal. Usually gas welding. Fast, surprisingly strong welds result.	Eutectic Welding Alloys, Inc.
BRAZING	Repairing cracked parts—cast or wrought. Welding tool tips to shanks. Making extension tools. Used on irons, steels and other high-m.p. metals.	Non-fusion welding, using copper, brass or silver alloy filler metal. Lowest temperature (1700°-1100° F.). Fast, strong joints. Uses torch, furnace heat, salt baths, induction, resistance heat, molten metal dip.	Handy & Harman (silver) Brass and bronze producers[4] Cutting tool manufacturers Heating equipment suppliers
HARD-FACING	Restoring cutting edge or wearing surface to broken or worn-down ferrous parts—scarifiers, grader blades, pug mill knives, valve seats, rolling mill guides, dies, etc.	Very popular and simple method of restoring worn parts or cutting edges to service. Can be renewed many times. Special grades are very hard or corrosion-resisting or heat resistant. Uses gas or arc welding.	Hard-facing alloy manufacturers[5]
METALLIZING	Building-up worn or mis-machined shafts, axles, journals, bearings, valve stems, etc. Renewing spalled or torn surfaces. Salvaging porous-surface light-metal castings. Used on all base metals. Many types of spray-metal available.	Consists in spraying molten metal by means of "metallizing" guns directly onto the surface being restored or built-up. Fast-depositing, often highly corrosion-resistant surfaces can be made. Manual or machine equipment available. Pre-treatment is very important. A most versatile process.	Metallizing Co. of America, Inc. Metallizing Engineering Co., Inc.
HARD-CHROMIUM PLATING	Electrodepositing a hard, wear-resistant surface on worn or mis-machined shafts, axles, journals, pistons, cylinders, valves, taps, dies, jigs, gages, bores, etc.	Gives very high hardness, wear-, corrosion-, and heat-resistance, and low friction coefficient. Requires special but simple electroplating technique. Work can be done to highest precision.	Chromium Corp. of America. United Chromium, Inc., or its licensees.

[1] *Arc Welding Machines*
Allis-Chalmers Mfg. Co.
General Elec. Co.
Harnischfeger Corp.
Hobart Bros. Co.
Lincoln Elec. Co.
Una Welding, Inc.
U. S. Electric Welder Corp.
Westinghouse El. & Mfg. Co.
Wilson Welder Co.

[2] *Gas Welding Supplies*
Air Reduction Sales Co.
Harris Calorific Co.
Linde Air Products Co.
National Cylinder Gas Co.
Victor Equipment Co.

[3] *Welding Rods*
Alloy Rods Corp.
Amer. Manganese Steel Div.
Arcos Corp.
Champion Rivet Co.
General Electric Co.
Harnischfeger Corp.
International Nickel Co.
Lincoln Electric Co.
Maurath, Inc.
McKay Company
Metal & Thermit Co.
Page Steel & Wire Div.
A. O. Smith Corp.
Karl Strobel Corp.
Una Welding, Inc.
Westinghouse El. & Mfg. Co.

[4] *Brass & Bronze*
American Brass Co.
American Mang. Bronze Co.
Ampco Metal, Inc.
Bridgeport Brass Co.
Chase Brass & Copper Co.
Revere Copper & Brass Co.
Riverside Metal Co.
Titan Metal Mfg. Co.

[5] *Hard-Facing Alloys*
Amer. Mang. Steel Div.
Callite Tungsten Corp.
Carboloy Co., Inc.
Coast Metals, Inc.
Crucible Steel Co.
Dymonhard Corp. of Amer.
Fansteel Metallurgical Co.
Firth-Sterling Steel Co.
Haynes Stellite Co.
Metal Carbides Corp.
Stoody Co.
Tungsten Electric Corp.
Vascoloy-Ramet Corp.
Wall-Colmonoy

Plainly labeled receptacles are provided by Western Electric Co. located close to each operator in the Hawthorne plant. Waste has been drastically cut.

practice, when the latter may be only "the straw that broke the camel's back."

Finally, special precautions should be applied to extend the life of tools and dies and keep them from too-early burial in the scrap pile. Tool designs should be closely examined and modifications that will improve the life applied. Workmanlike grinding, thorough lubrication in use and accurate setting are also vital to long tool life. To extend the life of forging dies, the stock, if possible, should be so heated as to keep scale formation at a minimum, since excessive oxide scale on the work considerably shortens die life.

Reclaiming Worn or Broken Parts

The methods of "preventing" scrap outlined in all of the foregoing serve the purposes of salvage with considerably more dispatch than the roundabout road of scrap collection, segregation and metallurgical conversion. But even if prevention fails — if parts, tools or dies through incorrect production practice of service-wear become offsize, worn or broken — recourse may still be had to direct salvage through repair, building-up, resurfacing, etc. No tool or part should ever be tossed into the scrap heap until it is certain that none of the modern commercial techniques for rehabilitating cracked or undersize parts is applicable.

Some astonishing life-extensions have resulted from intelligent use of such reclamation methods. In many cases the repaired unit far outlasts the normal life expectancy of a brand new part, and is often superior in ultimate performance.

The Table on page 251 presents some of the most widely used reclamation methods, indicates their specific applications (with some examples) and lists sources of detailed information about each (since even a thick book would hardly be adequate to cover this broad field practically and intensively).

Scrap Salvage

Despite the most intense application of scrap-prevention practices and techniques, however, a certain amount of unavoidable scrap is produced in every shop. (To this regular production scrap pile should now be added every obsolete or stored-away machine, jig, tool, die, or other non-reclaimable metal part). This scrap heap will be of use in easing the critical metal shortage in direct proportion to our efficiency in husbanding it and our watchfulness in keeping it segregated *from its source* to the point of ultimate conversion.

The articles that follow this one describe some of the scrap handling, sorting, segregating and converting practices that are being or should be employed in metal-industries plants. Careful reading of them will reveal certain persistently recurring recommendations, which may be assembled with a few other suggestions into the following list of generally essential pointers:

(1) Establish a salvage department and make some capable engineer responsible for its efficient operation.

(2) Impress upon each and every worker the vital importance to his country and, therefore, to himself of avoiding scrap and of keeping what scrap he does produce carefully classified.

(3) Segregate scrap at the source by studying each scrap making operation and providing simple, convenient means for collecting each material *separately*.

(4) Employ some kind of spot-checking procedures that permit rapid identification of material, both at the source and in the scrap yard, so that contamination of classified scrap can be held to a minimum (in this respect, see the sorting-method tables on pages 264-266 of this issue).

(5) Where it is feasible, use automatic magnetic-separation equipment (such as that made by Dings Magnetic Separator Co., Stearns Magnetic Mfg. Co., Magnetic Engineering & Mfg. Co., Ohio Electric Mfg. Co., and others) to separate ferrous from non-ferrous scrap — to keep tramp iron out of non-ferrous scrap or to prevent the loss of non-ferrous alloys through inclusion with batches of ordinary steel or iron scrap.

(6) If your foundry, melt-shop or grinding department residues are of sufficient amount and suitable nature, consider the possibility of directly classifying and reclaiming such waste in your own plant through the use of residue-reclaiming mills (such as those marketed by Dreisbach Engineering Corp., Hardinge Co., Inc., and others.

(7) Ferret out every last piece of metal not in process or use, identify it if its nature is unknown and return it either to production-use or to the nation-wide moving stream of scrap flowing toward our metal-producing mills.

PLANT SALVAGE PRACTICE

A SYMPOSIUM

Industry and the Nation face one of our most critical situations to date in the sudden emergence of a "fierce" raw materials shortage. At the moment our capacity to manufacture war goods seems to have nearly outstripped our ability to supply raw materials. The engineer's immediate answer is to "stretch out" what we have and return the scrap now on hand to the steel mills and non-ferrous refiners.

The ten articles in this symposium that follows are designed to tell how *to do these things in specific industries by relating the best practice of plants in each of several fields,—plants that have set up efficient, materials-saving salvage programs. Go thou and do likewise!*

—The Editors

Alloy Scrap in Steelmaking

by C. H. Herty, Jr.

Assistant to the Vice President, Bethlehem Steel Corp., Bethlehem, Pa.

Presented at the Symposium on "Engineering Aspects of Industrial Scrap Salvage," held under the auspices of the American Society of Mechanical Engineers, in New York, April 28th.

The tremendous use of alloy steel in the present war effort is one of the outstanding developments in the iron and steel industry. Alloy steels are used in armor plate, guns, tanks, airplanes, battleships, and the mechanized equipment so vital to modern warfare. The success of all of our offensive and defensive weapons is predicated on the use of alloy steels superior in performance to those of our enemies. For this reason, if for no other, the maximum utilization of available alloys is absolutely necessary.

The increase in the use of alloy steels has brought about a severe strain in the supplies of the alloying elements. For many of these elements we depend upon importations, in most cases in ships, for the great percentage of the total available material. This is true of manganese, chromium, vanadium, and tungsten, and intensive effort is being put into the production of these materials within the bounds of the North American continent.

However, with the increasing demands of the armament program, these domestic developments will still leave much to be desired in the satisfactory acquisition of the needed alloys, and for this reason every effort must be made to reclaim to the greatest possible extent the alloys which find their way into iron and steel scrap as a result of various manufacturing operations.

The preliminary shaping of a structural beam at a blooming mill. (Courtesy: United States Steel Corp.)

NET TONS OF 3.5 PER CENT Ni STEEL PRODUCED PER 1000 LBS. NEW NICKEL

Practice	Net tons ingots per 1000 pounds of new nickel
All new nickel used	12.8
Steel plant revert scrap recovered	16.9
Steel plant revert scrap and finished-operation scrap recovered	22.8
Steel plant revert scrap and refinishing-operation scrap recovered for special case of low finishing yield	31.2

Alloy Scrap and Its Importance

In the manufacture of alloy steel, a great many alloying elements are used either singly or in combination. These combinations involve not only the use of two or more alloys, but also the use of these alloys in variable concentrations in the steel. After the steel is made and poured into ingots, it is rolled or forged into a diversity of products which are then shipped to the trade.

Once the products have entered the trade, they are subjected to various operations, such as forging and machining. In the conversion from ingot to shipped product, there are certain irrecoverable losses, and a certain amount of scrap results which can be recovered and returned to the melt shop. In the consumer's plants, there is additional scrap produced in the various finishing operations, and in many cases this scrap contains a large proportion of the alloy originally used in the melt. The proper recovery and utilization of the scrap, both in the producer's and consumer's plants, is of great importance in our war effort, as this scrap amounts to a source of strategic alloys which can be used in addition to the virgin alloys brought into the steel plants.

The importance of scrap recovery can best be illustrated in the case of 3.5 per cent Ni steel by comparing the net tons of ingots produced per thousand pounds of new nickel from four practices, figures for which are found in the Table.

From these figures, the very great importance of recovering alloys from scrap can be readily seen. With a complete job of recovery in revert and finishing-operation scrap for an average product, the tons of nickel-bearing ingots have been almost doubled over that which would have been produced if all new nickel had been used.

The same relative tonnages of ingots hold for alloy steel containing molybdenum, tungsten, and cobalt because these elements are not oxidized during the steelmaking process and are thus almost 100 per cent recoverable. Chromium and vanadium are oxidized in the steelmaking process to a large extent and their recoveries are low compared to the elements previously mentioned unless certain special practices are followed in certain special grades of electric-furnace steel.

Utilizing Alloy Scrap

With modern steelmaking methods, including rapid methods of analysis, the use of alloy scrap presents two problems:

1. The ability to obtain the scrap in proper form for charging.
2. The certainty that the scrap charged will contain no alloys which are not permissible in the particular heat involved, or that these alloys are at least in amounts under the maxima specified or desired.

Consider first the type of scrap required for charging. Heats are slowed up and excessive losses by oxidation are encountered if the scrap consists of light bushy turnings which have a low bulk density and which in many cases are impossible to charge into a furnace in a reasonable length of time. Such turnings should be prepared in any manner that will increase their bulk density to the point where it becomes possible to charge them satisfactorily. This may be done by crushing, or briquetting, or both. Many other types of scrap can be charged direct or can be prepared by crushing.

Careful Segregating

With regard to undesirable alloys; it must be realized that the grades of alloy steel are many and that the effect of some of the alloys is very pronounced so that careful segregation of the various grades must be practiced if maximum utilization of the scrap is to be obtained. If nickel-molybdenum scrap is charged into a straight nickel heat, the amount of nickel recovered from the scrap may be determined by the extent to which molybdenum can be allowed in the product.

Furthermore, the charging of such scrap is a waste of molybdenum in the case in point, although such instances are sometimes unavoidable, depending on the character of heats being made and the character of the scrap available. The more careful the segregation of scrap the better opportunity there will be for this scrap's finding its way into proper-analysis steels, where it can be utilized to the fullest possible extent.

In many instances die steel, high in nickel and chromium, and cutting tools, containing large quantities of tungsten, have been found thrown into ordinary scrap piles. These types of materials should be relatively easy to segregate and if properly segregated would add considerably to our supply of the three alloys contained.

Large quantities of alloys are at the present time being wasted because alloy scrap is mixed with carbon scrap and finds its way into carbon heats. In a particular instance, cars of carbon scrap have been found to contain as much as 50 per cent of 3.5 per cent nickel scrap as a result of failure to segregate it in the scrap yards. This is not only wasteful of alloys, but also in many cases it is deleterious to the carbon heat because the resulting physical properties may make the steel unsuitable for its intended use.

Furthermore, in many cases, nonferrous and ferrous scrap are found in the same car. Many elements in nonferrous metals are distinctly injurious to steel and every effort should be made to keep the nonferrous material out of the ferrous scrap because, in addition to being deleterious from a steel standpoint, this practice is also wasteful of the nonferrous elements which are equally desirable of segregation on account of the critical shortages of most of the nonferrous metals.

Finally, it is believed with the proper pricing situation on segregated scrap the producer of such scrap will find it not only patriotic but profitable to do his utmost to make certain that his alloy scrap finds its way into the melting furnace in which it can do the most good for the war effort.

Salvage Problems in a Non-Ferrous Melt Shop

by R. T. Banister

Chief Metallurgist, Wilbur B. Driver Co., Newark, N. J.

The scrap-salvage problems of our company are probably of considerable general interest, since we are faced with handling the scrap of many entirely different classes of alloys. We produce electrical resistance and heat resistant alloys of the nickel-chromium, the nickel-chromium-iron, and the iron - chromium - aluminum types; electrical resistance alloys and thermocouple alloys of the copper, nickel and copper-nickel-manganese types; age-hardening alloys of copper-beryllium; electronic tube high-nickel and nickel-cobalt alloys; certain nickel-chromium stainless steels; and miscellaneous special grades.

Forms of Scrap

In the production of wire and strip, scrap necessarily is produced at the various stages of processing so that our scrap returns to the melt shop in many different forms. In the first place, from the melt shop and hot-rolling mill solid heavy scrap is returned. Quantities of each alloy processed at one time are large in these departments, and here the major shrinkage from ingot head and mill croppings occurs. Consequently the large proportion of revert scrap is produced here. Then in the grinding room where the billets are ground before final hot rolling to rod and strip there is produced the grinding dust which is finely divided metallic scrap contaminated with abrasive.

From the cold processing departments scrap is returned in varying sizes of wire and slittings. Where the size is small enough such material is compressed in a hydraulic press into small bales convenient to handle and then properly tagged for identification of grade. Heavier material is sheared to convenient length for handling and tied into bundles and also properly tagged. Since the practice employed in utilizing this scrap will vary with the form in which it exists it is necessary to keep the material classified into three main categories — heavy-melting scrap, baled scrap and grinding dust.

In addition to the above grades and types of scrap there is material purchased from outside sources and scrap from customers' fabrication operations which has been accepted. It is this type of scrap, which is kept in a class by itself, that offers greatest difficulty in utilization. Too often it is mixed as to grade of alloy. Separation, particularly when it is in the form of short pieces of wire is practically impossible.

It is clear that with the many and radically different types of alloys with which we deal the successful salvage of the scrap produced demands first that it be kept segregated. We accomplish this by maintaining in each department of our factory a well marked container for each of the more common grades, into which wire ends, etc. may be deposited at the time they are rejected from the stock being processed. Collections of the contents of these containers are made as frequently as necessary. The scrap is brought to the scrap department, baled or bundled, tagged, and stored for future use.

The processing of the less common grades is for the most part carried out at one time in a department and special containers are available for these grades at the time they are being processed. The heavy melting scrap is stored in specially marked containers in the scrap department the day it is produced. By collecting scrap at frequent periods and assembling it immediately in shape for use the chances of its identity being lost are reduced.

Remelting the Scrap

A second fundamental policy of our scrap-salvage program is to utilize the scrap as fast as it is produced so that less opportunity is permitted for mixing the grades. Since we know the average percentage of revert scrap we may expect from each heat we regularly include in our melting charge at least this percentage of scrap where that is possible. When available, scrap of the same grade being melted is utilized, but when this is not available, scrap of another grade is used and the balance of the change adjusted to give the desired final analysis.

In our particular plant since we employ Ajax Northrup high frequency induction furnaces for our melting we are fortunate in having low metal losses and consequent close analysis control. This however, is simple remelting; we are unable to carry out any refining operation, so can get out only what we put in. In order to meet analysis specifications we must, therefore, know what we are putting into the melting furnace.

This forces us whether we want to or not, to control our scrap carefully. It is a policy, however, that would appear sound for utilization of scrap generally. Metal fabricators who produce scrap in their operations could certainly contribute greatly to the efforts of scrap salvage if they could maintain proper scrap segregation practices.

In utilizing the different types of scrap—heavy melting, baled, etc.—somewhat different deoxidation and melting practice must be employed. The more finely divided scrap will oxidize more rapidly during melting than the heavy scrap. Experience has taught us the relative amounts of each that are desirable to use in a heat and the deoxidation practice to follow.

Grinding Dust

The scrap classification of grinding dust offers us our real problem and one for which we have not yet worked out a satisfactory solution. Up to recently we utilized a single dust collection system so that the grinding dust of all the alloys became mixed. The result has been that we have accumulated a quantity of abrasive-contaminated metallic dust that contained as the major elements nickel, chromium, iron and copper. Different lots of this have been thoroughly mixed and sampled and analyses obtained.

It appears to us that such materials could be used by steel makers for some satisfactory low-alloy steel where the above elements might be desirable. By varying the proportion of different lots of this material added to heats of steel the proportion of the alloying elements could be controlled. We ourselves have made a number of successful commercial heats "18 and 8"

stainless that contained copper. All of the nickel required was obtained from the grinding dust. Such a grade of stainless proved satisfactory for a number of applications. However, we normally do not melt "18 and 8" since our facilities are taxed with the higher alloys. We wish only to prove that the operation was practicable.

Recently we have set up our grinding so that the copper alloys are ground independently of the nickel-chromium alloys. We hope that if the dust of the latter is uncontaminated with copper, it may be more attractive to some one (assuming that we are unable to use it ourselves). We have also been working on the removal of the abrasive from the dust and our initial tests along this line appear quite satisfactory. The successful utilization of the dust has not yet been accomplished and, we imagine, other companies with a similar accumulation—are open to suggestions of how this may be accomplished.

A short time ago the question was put to us as to how many times scrap could be remelted before quality-deterioration set in. A case was cited of a foundry that continued to use revert scrap in the form of gates, risers, etc. until finally it was impossible to produce a satisfactory casting from the metal being re-melted. At this point it was necessary to throw out all the scrap on hand. Our answer to the question was that we had never reached that point. It is our belief that remelting of scrap in itself will not cause trouble but contamination may enter that can gradually build up to a dangerous point. If each heat is properly made and deoxidized and harmful elements are not permitted to be introduced, alloy ingots or castings equal to those from virgin metal can be produced using fairly high percentages of scrap.

Reclamation in a Foundry

by Edwin F. Cone

Editor

Segregation of alloys, whether ferrous or non-ferrous, and their reclamation is a topic very much in the public consciousness. Demand for alloying elements or the alloys themselves, due to the scarcity of most of them, makes it a patriotic duty to conserve them as far as possible.

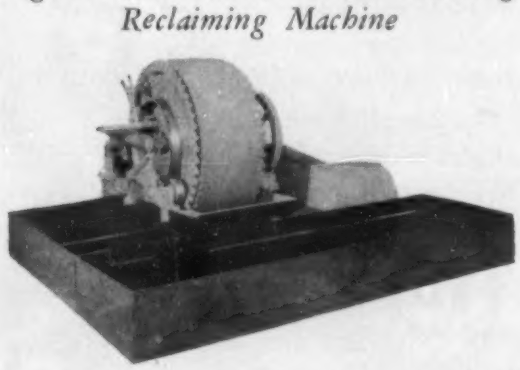
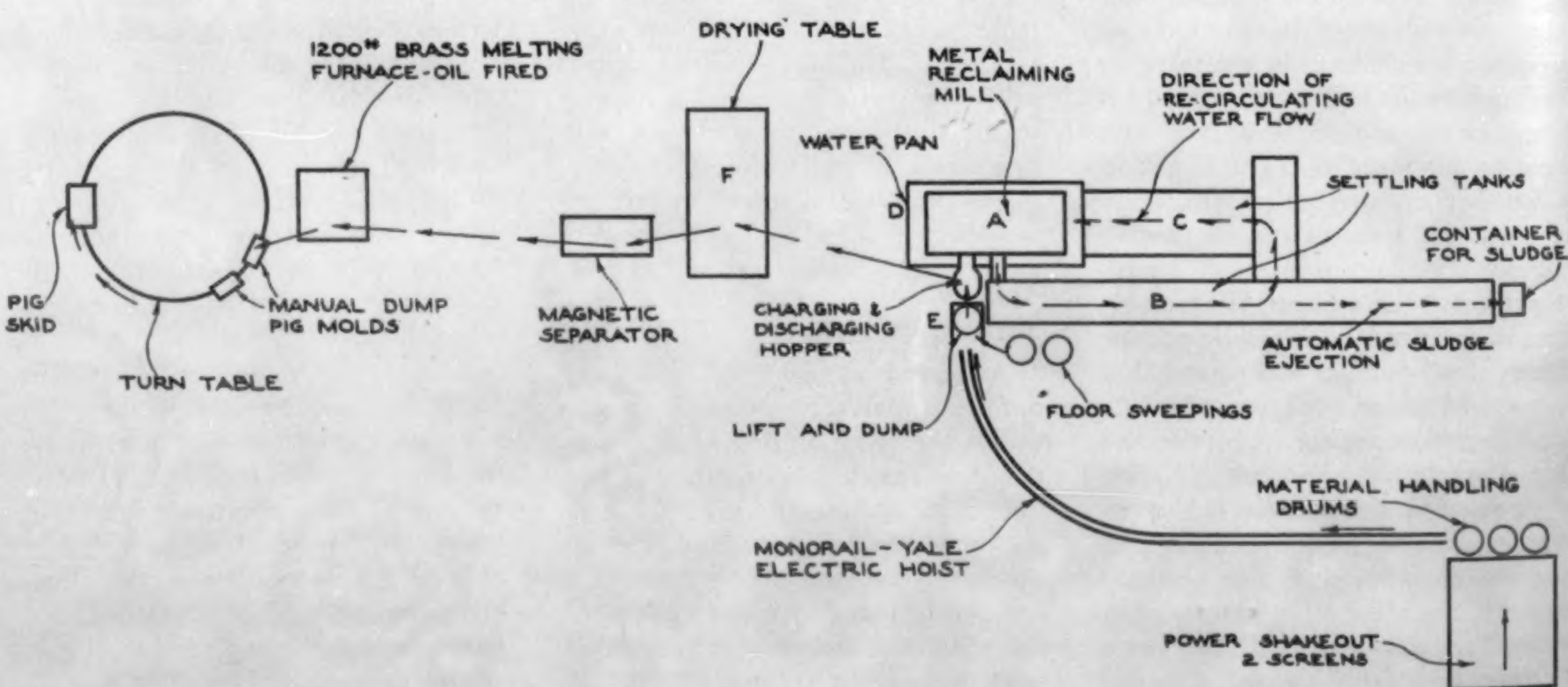


Fig. 1. The Dreisbach No. 5 Melting Reclaiming Machine

Someone has said that a 3 per cent drag (about 120,000,000 lbs. per yr.) in war production is caused by shiftless and careless mixing of non-ferrous alloy spills, sprues, risers and skimmings in foundries and mill casting plants. Hence the reclaiming of every pound of non-ferrous metal at the source should be stressed. A recent survey of foundries in the Middle Atlantic and Eastern states has revealed the fact that many of these are still operating with the old time wasteful practice of mixing all alloys into a common scrap pile. If this mass is reclaimed in that condition, it cannot be remelted into ingots, analyzed and alloyed for reuse in its original condition.

Segregation of all the skimmings, spills, etc., of each alloy and the recovery of each lot for remelting is possible. While such a procedure seems on the surface to be expensive or troublesome, it can be demonstrat-

Fig. 2. Floor Plan of the Reclaiming System, Including the Melting and Ingot Casting Apparatus.



ed that such a scheme with suitable equipment will result in profits which will more than compensate for the cost. This practice is now common in many foundries and mill casting shops with the result that a considerable tonnage is now going back into production.

It is interesting to record the experience of a plant which for sometime has been segregating its non-ferrous alloys, remelting them according to their composition and using them again in regular production. For many years the Yale & Towne Mfg. Co., Stamford, Conn., has reclaimed all metal from its non-ferrous foundry. Since the adoption of this practice it has been operating on only a 4 per cent metal shrinkage loss.

The apparatus which the Stamford company is now using is the Dreisbach Metal Reclaiming Mill, manufactured by the Dreisbach Engineering Corp., Yonkers, N. Y. In this the company is now milling all its skimmings, spills, sweepings and shakeout refuse, and recovering clean metal for remelting. Only one operator, a 5-h.p. motor, and recirculating water are needed. This mill was put in operation in December, 1940, and has milled about 5000 lbs. of material continuously every day during one shift. The tailings and sludge from the settling tank contain less than ½ of one per cent metallics.

Two illustrations represent this apparatus—Fig. 1, the general appearance of the mill, and Fig. 2, a line drawing of the entire set-up, showing the arrangement of a No. 5 mill and the supplementary apparatus for remelting the recovered products. The latter is an equipment specially designed and built by the Stamford company.

This recovery process is a wet one with a closed circuit recirculating water system and it is also made for dry process recovery. The settling tanks and mill water pan are filled with about 720 gals. of water. The water chambers in the drum fill and empty inside the drum as it revolves in the water pan and overflows into the settling tank B. All the pulverized waste material, including the oxides, having a low specific gravity flow from the mill.

The drum is designed to retain all particles of metal ranging from the smallest pellets to mill feed size. The waste material tailing or sludge settle in tank B and are de-watered and removed with an automatic sludge rejector driven by a 1-h.p. gearmotor into a large bucket. The water recirculates through tank No. 2 and into the water pan. Several gallons of water are added during the operation to replace the loss absorbed in the tailings. The concentrates or metal which are discharged from the mill drum vary in size from minute pellets to full mill feed size and are clean, 99.5 per cent metallics.

The installation of this mill plus space for operating occupies a floor space of about 360 sq. ft., with sludge ejection 500 sq. ft.

This mill, which replaced ball type mills, is reported to have halved labor costs with further savings on power and water costs.

The reclaimed metal is spread on a steam drying table, thoroughly dried and then fed through a magnetic separator which removes all the ferrous material. All reclaimed metal, segregated as it has been from the beginning, is melted in an oil-fired crucible furnace of 1200 lbs. capacity. In front of this furnace is an ingot mold turntable, mounted on ball bearings. Into these molds the various classifications of melted alloys are poured and each alloy melt is marked on the ingot.

This scrap casting department, shown on the illustration, is located in a room adjoining the space in which the reclaiming machine is situated.

A mill of this type is very necessary under today's conditions which involve all possible reclamation of metal or alloys from factory waste materials and it is doing an important job in assisting in obtaining the brass and bronze needed to keep the plant in operation.

Aircraft-Industry Salvage Kinks

by Harold A. Knight

Associate Editor

Aluminum scrapped and salvaged by the aircraft industry so far has been sufficient to build 250 Flying Fortresses, while the magnesium reclaimed is enough to build 500,000 incendiary bombs every month.

Theoretically at least, and perhaps practically, salvaging in aircraft plants is the most efficient, advanced and valuable throughout industry. In the first place, its chief raw materials are the critical ones—aluminum, magnesium and nickel steels—hence, maximum need for saving. Secondly, aircraft is a modern industry, without the moss-back traditions and therefore is psychologically in a position to install efficient systems—say in salvaging—at the start.

General Trends

There are interesting and somewhat conflicting theories regarding salvaging. One school of thought reasons that when workmen know everything will be salvaged they are careless about dropping rivets, bolts, nuts, etc. on the floor. Moreover original stock is not ordered close to pattern and little, if any, care generally is exerted to prevent waste. The ideal salvaging campaign therefore combines reclamation of waste with education of employees against making waste.

One aircraft company has eight girls spending full time in salvaging and sorting, the actual cost to the company being 50 cents per pound for sorting bolts and nuts. Of course during this war emergency costs of things are not of primary consideration.

The tendency is to use more and more machinery for saving and segregating scrap. One company has a moving belt under all machine tools working in steel to carry borings and turnings away.

Another company has a sorting machine, incorporating a magnetic separator. The latter, of course, divides the ferrous materials from the nonferrous. A blower eliminates the rivet and other drillings. A rubber belt conducts items over graduated holes, the larger items falling through the larger holes, etc., but, of course, not necessarily the same items. These have to be sorted by hand. It can sort 600 lbs. of material per hour. About 8,000 lbs. of usable small production items are recovered weekly by running floor sweepings through the separator.

What Specific Plants are Doing

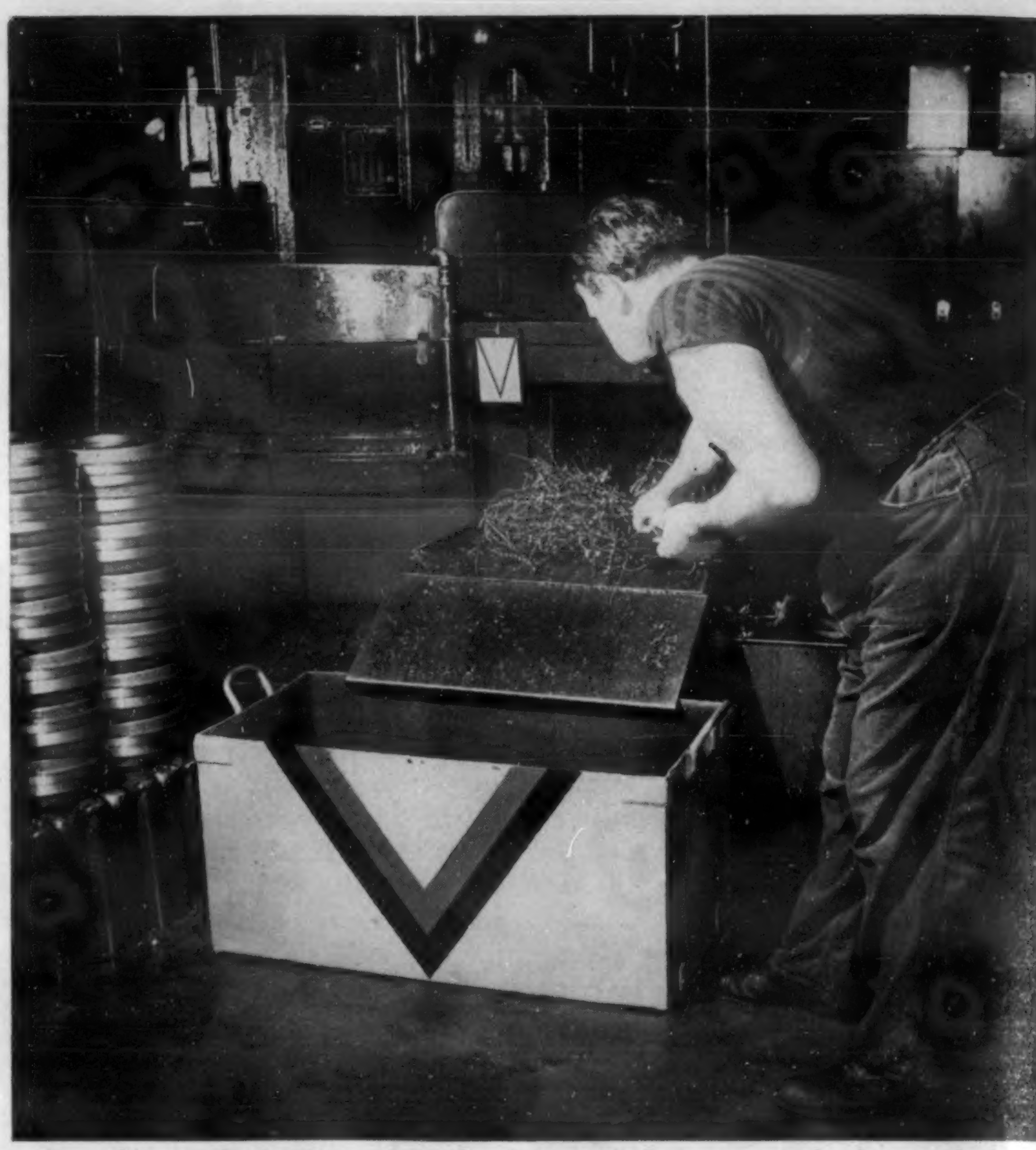
WPB has been rating each aircraft plant with regard to how much of their salvaged material is segregated. For last March Boeing led the list at 95.38 per cent, observes *Automotive and Aviation Industries.*

One plant notes that since machine tools are so close together, with changing of materials so rapid, it is impossible to do a complete segregation job, resulting in 80 per cent segregation of aluminum and 20 per cent mixed scrap.

From a spectacular standpoint Wright Aeronautical Corp. stands out because of its "color system." Suppliers of metals are asked to paint code colors on the ends of all sheets entering the factory. The identifying colors stay with the scrap all the way to the main segregated bins.

Only another Barnum could have devised the color and V-system (V for Victory and vital metals, as Wright's house organ expresses it). On each machine tool is the V color card, perhaps blue and yellow to denote pure copper, in a rack, indicating that machine is working on copper stock. Soon a hand truck appears, also with the V — blue and yellow design, and into it is scooped the shavings from a bin near the machine, also with the key insignia. The hand truck takes the shavings to a master bin in the reclamation yard.

Typical of metals saved by an aircraft company are those of North American Aviation which are: aluminum and aluminum alloys (broken down into 24S bare, 24S painted, 52S, 2S and other grades mixed), magnesium and steel (segregated into stainless, chrome-molybdenum, nickel, low carbon and high speed tool steel.) Other metals segregated are aluminum, bronze, brass and copper.



A machine tool operator at Wright Aeronautical Corp. transferring steel shavings into a portable salvage receptacle. The colored "V" on the machine indicates the type of scrap it is making, and the "V" on the receptacle must be of the same color to accept the scrap.

Considerable effort is expended to educate workmen to cooperate in the salvage campaign. One aircraft maker publishes interesting reclamation articles in its house organ. Lockheed-Vega has instituted a series of graph charts to enable supervisors and workmen to better visualize the waste of materials. As a result of its campaign Lockheed, at two of its plants, reduced the volume of mixed bolts, nuts, screws, rivets and other components by as much as 80 per cent.

Douglas Aircraft Co. has compiled a group of "Tokio Kid" posters showing the smug satisfaction that comes over the Jap's face when rivets are mixed and tools broken. Not only are these posters displayed in the Douglas plants but also in the shops of subcontractors.

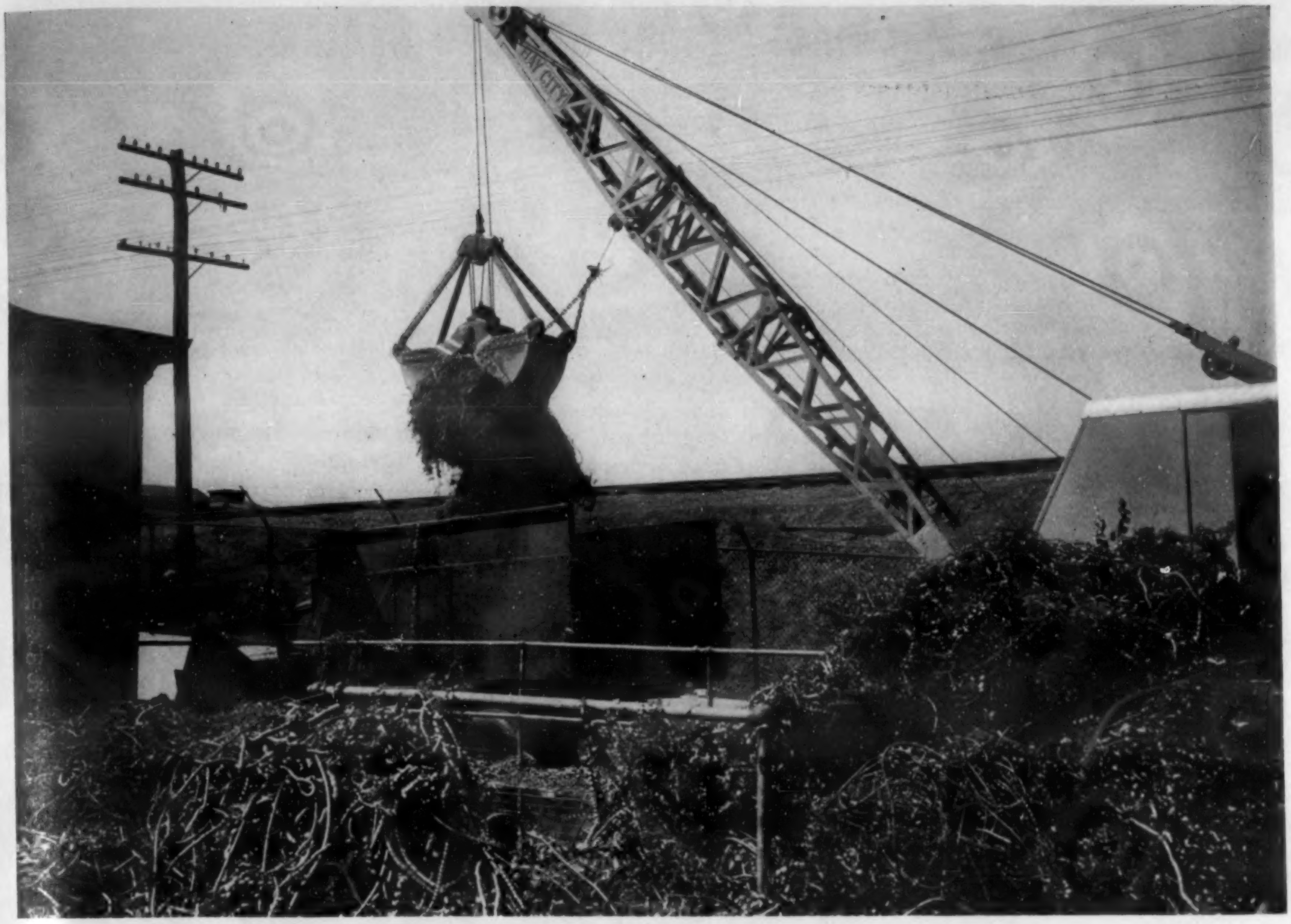
While riding the crest of the wave of education Wright has gone a step farther and persuades employees to carry on conservation at home. Handy to the entrances of plants are receptacles, labeled: "Win with Tin." Here workmen place what were formerly tin cans properly cleaned, delabeled and flattened. Wright, incidentally, has the reputation of having been the first company in the aviation field to set up a comprehensive "all out" program of materials salvage.

Sorting Practices

Hand labor of course dominates all salvage work in an aircraft plant where there is such a multiplicity of parts and materials. Several hundred sorting operations sometimes are required before all the parts are identified and segregated, comments *Aero Digest.*

On the other hand mechanization reaches a high standing at one of the Wright plants where a special chip-handling system emptying into overhead hopper can load a gondola car in 8 minutes.

At the Bell Aircraft Corp. aluminum rivets are swept up and saved, as in all plants. However flush rivets



Cleaned of cutting oil, these steel shavings produced in the machine shops of Wright Aeronautical Corp. are being loaded in a central salvage yard for shipment to steel mills and quick re-application to war use.

cannot be used after their thin edges have been damaged. Accordingly these are sent to a vocational high school where they are used by young aviation trainees, who will soon be building aircraft in earnest.

In several plants Kirksite (zinc-alloy die material) turnings are sent to a smelter; their steel content is removed and the remaining metal brought back to the plant in the form of ingots.

Used drills, reamers and other cutting tools are usually melted down to save their high grade steel. Cutting oils are salvaged from oil-soaked chips by the use of centrifugal separators.

Best salvage results where the campaign is planned centrally, rather than by a hit or miss program, each department for itself. North American Aviation's savings of scrap metals inincreased in March 1942 by 139 per cent over the average of the previous eight months because of the more integrated program.

Lockheed has reduced waste material about 45 per cent in the last three years. Vultee's conservation department saves 25,000 pounds of material weekly.

Douglas constantly tries to reduce the ratio of scrap to other materials though actually the poundage of scrap is double a year ago because of much greater production of aircraft. However the ratio of scrap has been reduced 12 per cent from two years ago and by 50 per cent from three years ago.

During 1940 23,000 pounds of rivets, worth $15,000, accidentally dropped to the floor. Sorting them on special machines and inspecting them for reuse added 50 per cent to the original cost. Such estimates of costs and education of workers on these figures, however, accomplished a 60 per cent decrease in droppings over a year.

Auxiliary Advantages

The large quantities of scrap collected in the industry always suggests taking of steps to create less scrap. Original material is now usually ordered to more exact size of finished product. In this connection, Walter White, manager, salvage survey department, Lockheed-Vega states:

"We are changing templates to reduce the blank sizes to a minimum, changing drop hammer dies, punch press dies, shear sizes in the master route sheets in the manufacturing engineering department, changing materials and substituting to enable us to use all the odds and ends from the shear section, securing changes for more economical fabrication both in material and labor."

A somewhat whimsical touch is that salvaging often provides what might be termed a "lost and found" department. Many small tools, hidden in the sweepings, are found and returned to their owners, where identified; otherwise placed in the general stock.

Hardly a week passes without some new wrinkle being devised and some new item reclaimed, some so simple it is a wonder it had not been thought of before.

A Machinery-Plant Salvage System

by Robinson D. Bullard

Reclamation Engineer,
The Bullard Co.,
Bridgeport, Conn.

Presented at the symposium on "Engineering Aspects of Industrial Scrap Salvage," held under the auspices of the American Society of Mechanical Engineers, in New York, April 28th.

Machine-shop reclamation applies primarily to the recovery of the waste materials of production. Therefore, a salvage department, having a competent man familiar with this work at its head, should be established. Following are some of the practices that have been established successfully in our plant.

The nature of our work requires the use of a great number of cutting tools. When these are worn beyond a certain point, or broken, they are inspected and catalogued. If possible, these tools are reconditioned for further use in other departments of the plant. Where this is not possible, we have found that other manufacturers, in our community, whose work does not require the best in tooling, can often get many additional productive hours from such tools.

In all machining operations where cutting oil is used, normally about 30 per cent of this oil is removed from the machine on the turnings. This can be reclaimed by two methods, namely, either by providing self-draining chip-storage bins, or by mechanical extraction. For the smaller plant the self-draining bin is probably the more practical method. However, where a large volume of chips must be handled and the storage problem is a serious one, mechanical extractors offer the most efficient means of reclamation. In either case, however, the oil should be thoroughly cleaned before it is used again.

Chip Salvage

Of all the reclamation work in the machine shop one of the most important branches is the recovery of the material removed by machining, such as cast-iron borings and steel turnings, which may contain a very considerable amount of alloying elements such as nickel and chromium. To do this. we have installed a complete system for converting cast-iron borings and steel turnings into material suitable for remelting.

In planning this system we first developed a flow diagram, Fig. 1. From this it will be noted that the material is segregated at the production machine by providing a number of properly marked, oiltight boxes. These boxes are further identified by painting them different colors. The colors indicate what type of material they contain, such as cast-iron borings, carbon-steel turnings, or alloy-steel turnings. The boxes are then transported to the chip department where the various types of material are classified and stored prior to processing.

The cast-iron borings are briquetted without any preliminary treatment other than screening to remove shop refuse. The steel turnings, prior to briquetting, require crushing, and if they are machined with mineral cutting oil, this must be extracted.

After briquetting, the different briquettes are conveyed to separate storage hoppers accessible to our cupola charging crane. Fig. 2 shows the approximate layout of our equipment. All toteboxes are handled by an overhead monorail.

The cast-iron chips are dumped into a self-feeding hopper and carried by a scraper-type conveyor to one compartment of the main storage hopper which is located over the briquetting machine. The steel turnings are dumped onto a deck and then fed manually into the crusher. Those steel turnings that were machined with min-

Fig. 1. Flow diagram for machine-scrap in the Bullard system

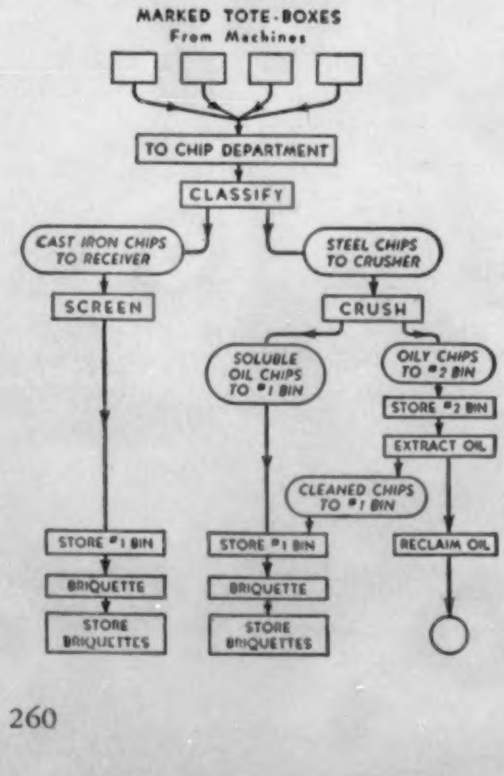
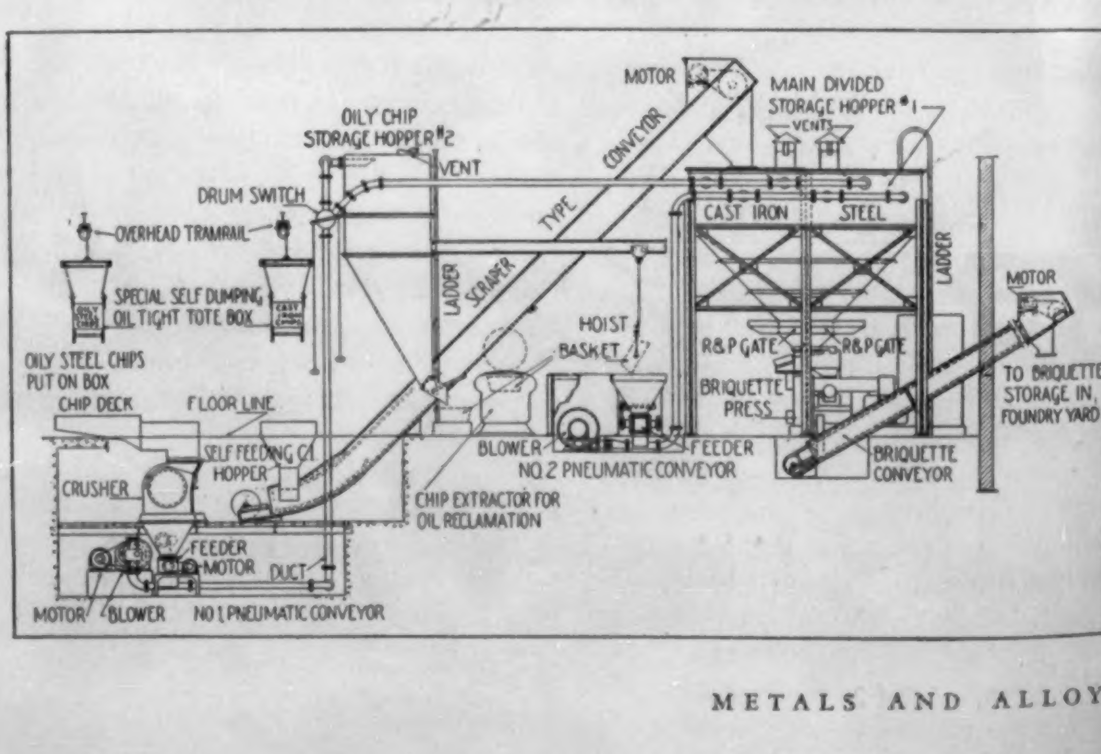


Fig. 2. Layout of mechanical scrap-handling installation at the Bullard Co. (Drawing supplied by National Conveyors Co.)



eral cutting oil are conveyed pneumatically from the crusher to storage hopper No. 2. The oil is removed by a centrifugal extractor, and the clean chips are then dumped into the intake hopper of another pneumatic conveyor which carries them to a compartment in the main storage hopper previously mentioned.

The steel turnings that were not machined with mineral oil are carried directly to a compartment in the main storage hopper. This arrangement provides independence of operation for the crusher and the chip extractor. The chips from the No. 1 hopper are briquetted and then conveyed to the various storage bins.

The briquettes are disposed of in two ways. First, the alloy briquettes are being returned to one of our alloy-steel suppliers, and secondly, the remainder of the briquettes make up 35 to 40 per cent of our foundry needs. In some heats as high as fifty per cent briquettes are used with entirely satisfactory results.

As a direct result of all these reclamation operations in our plant, we are now saving over 25,000 gals. of lubricating and cutting oil a year, over 125,000 lbs. of woolen and cotton waste, and producing approximately 15,000,000 lbs. of briquettes, which will contain about 35,000 lbs. of chromium and 75,000 lbs. of nickel.

Salvage at a Tractor Plant

by R. W. Hughes,

Manager, Reclamation Dept., Caterpillar Tractor Co., Peoria, Ill.

Naturally those industrial manufacturing plants that have carried on systematic salvaging and reclamation for several years find it "duck soup" to fall in line with war salvage efforts. Their experience can often well be used as a model for newcomers.

Such is the Caterpillar Tractor Co., Peoria, Ill., which established an efficient salvage department five years ago. So well built up are stocks of salvaged ferrous material that the foundries of Caterpillar can often run for weeks without buying raw material from outside sources. Thus gray iron borings are pressed into briquets, thence charged into cupolas, 33 tons daily being produced. All ferrous scrap material, 12 gage and lighter, is compressed into bales for foundry use along with skeleton stock, wire, nails, slugs, stringers and rusty barrel hoops.

Workers are decidedly salvage conscious. By his own initiative each machinist, upon finishing a run of some steel material, consults blue prints and, if a different material is scheduled, sweeps up all chips and turnings, placing them in a well-labeled barrel or bin, so that the new material will not mix with the old.

Chips, borings and turnings are segregated into four groups: Mild steel, nickel steel and iron, molybdenum steel and iron and gray cast iron.

Large signs are supplied by the Reclamation department to the various operating departments to guide the scrap collecting men who circulate through the plant. Upon reaching the reclamation department doubtful scrap is "spot tested," or given a rapid qualitative test to identify it accurately.

Steel scrap is remelted in the iron foundry cupola. In the early days fine particles were baled to prevent loss up the stack, but more recently it is briqueted, thus applying generally what was already used on gray iron borings.

Larger parts, such as alloy steel bar ends, and other scrap parts and alloy cast iron scrap parts are accumulated in yard bins for foundry use.

Not all material is destined for remelting. Thus sheet-metal croppings and slugs are often converted into parts, thus reducing materially the amount of new sheet stock which must be bought for this purpose. Now inventories of these collected pieces, classified as to size and shape, are kept scrupulously, and can be furnished on order, for the manufacture of sheet metal parts replacing new material. Usually these scrap pieces are more welcome than new material since less shearing to size is needed. Last year upward of 1700 different parts, totaling over 3,000,000 pieces, were made from materials handled as described.

Much of the collected scrap, where not reusable by Caterpillar, is sold. Thus scrapped tool steel materials and parts from discarded fixtures are sold to producers of high-speed tool steels.

Naturally, much spoiled work automatically becomes scrap. Typical are alloy cast iron cylinder liners which must be machined to such close limits that considerable spoilage is scarcely avoidable. They are shipped to the foundry on days when the same material is being poured. Heavy scrap is reduced to cupola size by alligator shears or torch cutting.

Alloy-bearing scrap salvaged at Caterpillar in a year will contain about 110,000 pounds of critical alloys. The metallurgist at the foundry, being especially well acquainted with all of Caterpillar's processes and analyses, can gage the amount of alloy in the scrap turned over to him by appearance of the scrap. He can add the correct amount of other alloys, where necessary, with certainty of proper results.

Ingenious repairs to tools have been accomplished. Thus in case of worn sprocket rims, these are removed from hub and spokes and new rims welded on.

Changes in cutter designs have multiplied normal life several times. Study

of grinding wheels has led to many new uses after they have been taken off the original machines. By standardization of arbor holes the same wheel can be used on three different machines and still provide them with the grain size and bond that is needed in each particular job.

Non-ferrous metals are salvaged also. Aluminum borings and turnings are carefully accumulated. About 1,000 lead hammers for general factory use are made monthly from scrap lead, discarded grinding wheel bushings and old hammers.

Welders' training courses have their laboratory work in the reclamation department where spoilages cause no waste.

Accumulated scrap collections are transported to the main scrap yards by narrow gage track.

Here is a typical year's turnover of chief items at Caterpillar's reclamation department: Loose turnings, 34,497,120 lbs.; heavy melt, 24,941,280 lbs.; cast iron briquettes, 19,529,400 lbs.; gray iron castings, 6,954,240 lbs.; light gage material, 8,559,120 lbs.; nickel steel bales, 5,630,290 lbs.; nickel iron castings, 1,009,440 lbs.

Other items classified, but under 1,000,000 lbs. each, are: Nickel steel forgings, aluminum brass, bronze, copper, solder dross, lead and babbitt.

A Railway Salvage Program

from "Railway Age" July 4, 1942

Much of the scrap drive from now on will be second or third "combings"—making searches over the same fields and discovering hidden or obscure sources. That is what the Illinois Central Railroad did.

This carrier conducted an intensive drive for scrap collections in July and August, 1941. However, the little Pearl Harbor episode, of course, changed things, so Illinois Central started a new drive on Feb. 10, 1942.

At one point a manhole over an underground steam tunnel led to a large collection of reclaimable valves and pipe fittings of all sizes. In another place a stock of dies and shop tools, hidden for years, was brought to light.

In two dust-covered boxes in the attic of another building there was found in good condition $700 worth of parts for a machine tool which was no longer in use in that locality, but were materials needed badly in another shop. Old record rooms and old underground passages for pedestrians yielded material.

Abandoned buildings furnished hardware, electric wire, gas piping, water-lines and plumbing fixtures. There were several instances where water, air, steam and oil lines had been left in the ground at the time old pump houses and other buildings were removed, some piping having been 6 ft. underground. One job consisted of digging up 1200 ft. of 24 in. cast iron pipe.

A prolific source of scrap was trash dumps along the right-of-way or near new and old engine terminals. They contained galvanized sheet, wire cable, banding iron, rubber hose, dry cell batteries, iron pipe, journal boxes, couplers and various brass scrap.

In one case a dump which was thought cleaned out in 1941 after removal of 36 carloads, yielded 356 tons of No. 2 sheet scrap, 21 tons of miscellaneous iron and steel scrap, 100 lbs of journal brass and 200 lbs. of No. 2 brass, valued at $2,961 as against costs of collecting and sorting of $1,533.

Much scrap recovered was far from being railroad scrap, the public often using the railroad's right-of-way as a public dumping ground, such scrap consisting of tin cans, automobile bodies, etc.

As rapidly as the material is gathered it is moved to the nearest of many scrap yards. At the yards the scrap is sorted and decisions made as to what is reusable and what is merely scrap.

From the individual yards all material is shipped to reclamation plants, largest of which is at Burnside, near Chicago. Here further sorting for reusable parts is conducted.

In three years since 1939 the Illinois Central sold over 330,000 tons of iron and steel scrap and over 7,500 tons of non-ferrous material. About 25 per cent of the collections are reconditioned for further use.

The best administrative and technical brains of the railroad are on the salvage committee. A special car is placed at the disposal of the main committee. Every employee is enrolled for salvage work, all of which is the best kind of teacher against waste in the future.

Veteran employees were particularly encouraged to assist in locating forgotten sources of scrap material and some employees were paid for unusually valuable suggestions.

The elaborate salvaging system of the Illinois Central does not always pay off financially—the balance is written off in the patriotism column.

Scrap Recovery at a Large Electric Plant

by F. A. Shewmake

Nassau Smelting & Refining Co.

Electric industry companies have long specialized in segregating scrap. Metals which they use are so uniform and well standardized that officials do not hesitate to use reclaimed material.

The main problem is to segregate these used materials, keep them segregated and properly labeled. A system has been worked out usually to make sorting and segregation as fool proof as possible.

One company far advanced in scrap salvage is the Western Electric Co., as well as its affiliated company, Nassau Smelting & Refining Co.

A large proportion of the non-ferrous scrap of Western Electric is produced in manufacturing operations at the large works at Hawthorne, Ill. Final stages of reclamation are at Nassau.

Segregation is not simple. In the company's group of nickel alloys alone lie those of such varying composition as nickel silver containing 18 per cent Ni and the permalloy group containing 45 to 82 per cent Ni. Besides the company's own regular products there are also scrap nickel alloys from purchased material such as heat resisting alloys high in nickel.

Segregation of machine scrap is one of the important salvaging operations at Western Electric. Detailed instructions for the segregation are called layouts. Reference numbers are given to all grades of material. The lay-out specifies the type of machine to be used for each operation and the nature and sequence of operations.

The "machine setter" has the layout before him and makes a note of the composition of the scrap which will result from the particular operation. If the alloy content is different from that used on the job preceding, the machine and scrap receptacle are cleaned thoroughly. Machine operators are instructed to place the scrap in designated portable containers.

Tags are attached to containers with proper data, such as department originating the scrap, the grade (perhaps Grade A, Brass) and the kind of cutting lubricant used. Tags stay on containers until the final packing or until ready to be placed in the oil extractors in case of turnings and chips.

Oil extraction and recovery, as well as final classification and packing, are assigned to especially trained operators who can usually detect any mixtures or classifications which are erroneous. Where mistakes are found the supervisor from the erring department is summoned to inspect the wrong sorted scrap and he is reminded of the necessity of proper handling and told of price differentials existing among various grades of scrap.

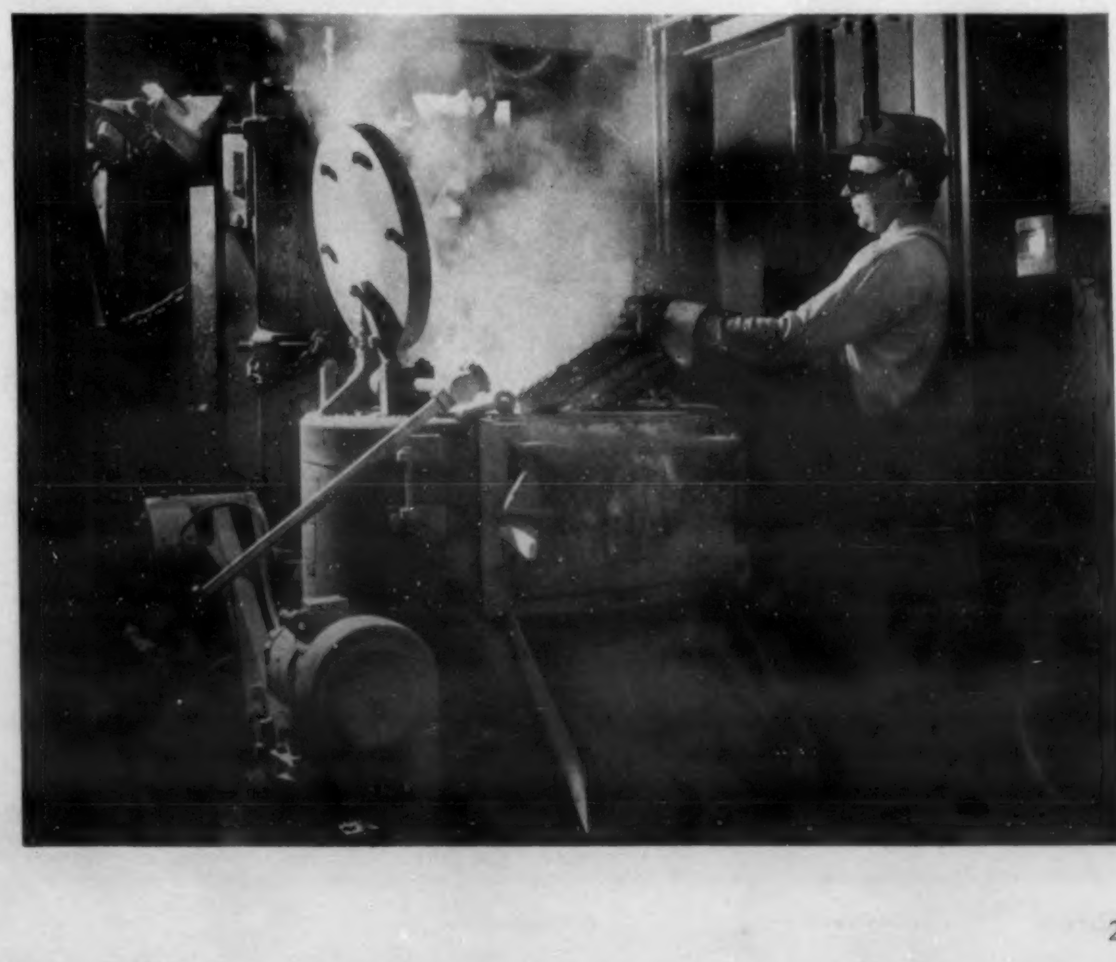
There are three common sources of contamination. First, is dirty containers. Often oily metal chips adhere to the inside of empty scrap containers after the containers have supposedly been completely emptied. It is best of course to always use the same container for any one grade of scrap. Otherwise, they should be cleaned thoroughly.

Second, is contamination by careless handling in transporting from the point of origin to the scrap department. Often containers with scrap are piled one on top of another and oily chips adhering to the bottom of one container may drop off into the top of another containing a different grade.

Third, is contamination because of improperly instructed employees. Where all men in the operation department may have been fully trained on segregation, other departments, off the main stream of operations, such as maintenance and repair, may be less expert. A member of the scrap department inspects their waste bins periodically and rectifies mistakes before it is too late.

When the scrap is properly segregated and labeled at the Western Electric plants it is shipped to the Nassau plant for treatment. There the various grades are remelted in induction and arc furnaces, to which additions are made to bring the material to a desired composition, ready for reuse. Even the rinse water from plating operations is examined and treated.

One of the furnaces for melting reclaimed metals such as nickel silver and other non-ferrous alloys operating at Western Electric's Hawthorne Works.



Reference Tables of

RAPID SCRAP-IDENTIFICATION TESTS

Compiled by The Editors

Material	Surface Appearance	Pellet Test after Sparking[1]	Magnet Test	Lathe Chip Test	Blowpipe Test
Gray Cast Iron	dull gray; evidence of sand mold		magnetic	short (1/8 in.) chips	moderate melting speed; quiet slag; quiet puddle
Austenitic Nickel Iron	gray; mold texture		non-magnetic		
Plain Carbon Steel	dark gray; may be rusty	dark, rounded, smooth surfaces	magnetic	long, often continuous	fast melting; quiet slag; puddle sparks
Nickel Steel	dark gray; surface condition varies		magnetic		
Chromium Steel	dark gray; surface condition varies	gray, frosty color; rounded particles	magnetic		
Tungsten Steel	dark gray; surface condition varies		magnetic		
Molybdenum Steel	dark gray; surface condition varies	(high carbon) hollow hemispheres	magnetic		
Vanadium Steel	dark gray; surface condition varies	black, truncated (hollow) shells	magnetic		
Straight-Chromium Stainless	dark gray; sometimes black-red rust		magnetic		
18-8 (or 25-12) Stainless	dark gray; dull to brilliant; usually "clean"		non-magnetic		
Inconel or Similar Alloys	dark gray; usually "clean"		non-magnetic		
Nickel	dark gray; smooth; sometimes green (oxide)		magnetic	cuts easily; smooth edges; can be continuous	melts slower than steel; less slag than Monel; quiet puddle
Monel	dark gray; smooth		slightly magnetic at room temp.	cuts easily; smooth edges; can be continuous	melts slower than steel; considerable quiet slag; quiet puddle
"Nickel Silver"	gray to yellow or yellow-green		non-magnetic	smooth, long, often continuous chips	moderate melting speed; fumes
Brass	yellow to green or brown		non-magnetic	smooth, long chips; more brittle than copper	moderate melting speed; gives off fumes; puddle like water
Tin Bronze	red to brown		non-magnetic	smooth, long chips; more brittle than copper	fast melting, some fumes; puddle like water
Aluminum Bronze	yellow-brown		non-magnetic		
Copper	smooth; red-brown to green (oxides)		non-magnetic	smooth, long easily cut chips	slow melting; very little slag; puddle bubbles
Aluminum	light gray to white; dull or brilliant		non-magnetic	smooth chips; saw edges where cut; chips can be continuous	very fast melting; quiet, black scum forms, quiet puddle
Magnesium Alloy	white; surface coating may be yellow-brown		non-magnetic	short, easily cut chips	
Lead	smooth, velvety; white to gray		non-magnetic	cut by knife; any shape chip	melts very fast; quiet slag, dull gray coating; quiet puddle
Lead-Silver Solder	smooth; dark gray; sometimes discolored		non-magnetic	harder than lead; any shape chip	slower melting than Pb or Pb-Sn
Lead-Tin Solder	smooth; white to gray; may be frosty		non-magnetic	harder than lead; any shape chip	faster melting than Pb-Ag; about same as lead

[1] The "pellet test" (Hildorf & McCollam, *The Iron Age*, Vol. 126, July 3, 1930, p. 1) is an adjunct to the spark test, and is especially useful for steels difficult to identify by the spark test. In the pellet test, grindings of the specimen are collected, passed through a 100 mesh sieve and the large pellets examined under an ordinary bench microscope. The pellets from various alloys vary characteristically in shape, texture and color.

No matter how carefully instructions to avoid scrap "mixups" are heeded, some confusion of materials is unavoidable. An essential engineering aid in avoiding or correcting such mixups is a set of reliable quick identification tests, such as those presented on these three pages. The behavior of common "scrap" materials in some widely used physical tests (page 264), chemical "spot" tests (below) and spark tests (page 266) is tabulated for convenient reference. The "unknown" is usually known to be one of two materials, in which case the data for both materials in the Tables should be followed horizontally until a test is located in which the materials behave differently. If none such is found among the physical and chemical tests, the material may be identifiable by spark testing.

These data were obtained from the personnel or publications of Climax Molybdenum Corp.; International Nickel Co., Inc.; Linde Air Products Co.; Nassau Smelting & Refining Co.; and The Norton Company.

Material	Chemical or Spot Tests			
	1 Nitric Acid	2 "Iron Nail" Test	3 Ammonia Test	Others
Gray Cast Iron	reacts; brown to black solution		red-brown	No. 4—No red color
Austenitic Nickel Iron	reacts slowly; brown to black solution		red-brown	No. 4—Intense reaction
Plain Carbon Steel	reacts; brown solution		red-brown	No. 4—No red color
Nickel Steel	reacts; brown to greenish-black soln.		red to purple	No. 4—Red color, intensity corresponds to amount of nickel
Chromium Steel	reacts; brown to black solution		brown-green	No. 4—No red color in nickel-free steels
Tungsten Steel	reacts slowly; brown soln., yellow sediment		red-brown	
Molybdenum Steel	reacts; brown to black solution		red-brown	
Vanadium Steel	reacts; brown to black solution		red-brown	
Straight-Cr Stainless	no reaction		brown-green	No. 4—No red color
18-8 (or 25-12) Stainless	no reaction		reddish-blue	No. 4—Intense red color; No. 6—Copper deposits on dilution
Inconel or Similar Alloys	no reaction		blue-red	No. 4—Intense red color; No. 6—No copper is deposited
Nickel	reacts slowly; pale green solution	negative	blue	No. 4—Intense red color
Monel Metal	reacts; greenish-blue solution	copper plates out	dark blue	No. 4—Intense red color
"Nickel Silver"	reacts; bluish-green solution	copper plates out	dark blue	No. 4—Red color varies in intensity with nickel content
Brass	reacts vigorously; green solution	copper plates out	dark blue	No. 4—No red color in nickel-free alloys
Tin Bronze	reacts vigorously; blue-green solution	copper plates out	dark blue	
Aluminum Bronze	reacts vigorously; blue-green solution	copper plates out	white ppt.; blue soln.	
Copper	reacts vigorously; blue-green solution	copper plates out	dark blue	
Aluminum	Soluble		white precipitate	
Magnesium Alloy	Soluble		colorless	
Lead	Soluble		colorless	No. 5—No precipitate
Lead-Silver Solder	Soluble		colorless	No. 5—No precipitate in absence of tin
Lead-Tin Solder	Soluble		colorless	No. 5—Black deposit with white ppt.

Spot Test Procedures

Test No. 1—Nitric Acid Test: Place 1 or 2 drops of concentrated nitric acid on the clean metal surface. Observe any reaction for 1-2 min. Then dilute with 3-4 drops of water, and observe reaction. If solution turns green or blue, use it for the "iron nail" test.

Test No. 2—Iron Nail Test: Rub a clean iron nail in the colored acid sol'n., in contact with the specimen. If the alloy contains copper, copper will be deposited on the nail or the metal surface.

Test No. 3—Ammonia Test: Dissolve a bit of the metal in nitric acid, or attack the surface with a few drops of acid (use aqua regia for stainless steel, Inconel, etc.). Dilute somewhat, carefully add ammonium hydroxide to the sol'n. until the latter is strongly alkaline. If copper or nickel is present, a pale blue precipitate will form, which on further ammonium addition becomes a dark blue sol'n.

Test No. 4—Paper Test for Nickel: (Williams, *Ind. & Eng. Chem.*, Jan. 1942). One drop of acid mixture (10 ml. H_2SO_4, 10 ml. HNO_3, 10 ml. H_3PO_4, 10 g. citric acid, 25 ml. water) is placed on the metal for 15-30 sec., then absorbed in a paper test strip (filter paper dipped in a sol'n of 10 g. citric acid, 25 ml. H_2O, 10 ml. of 1% dimethyl glyoxime in isopropanol, and dried). When KOH is dropped on the paper, a red color will form if nickel is present. This test is free of color interference from iron or other elements.

Test No. 5—Silver Nitrate Test for Tin: Treat the clean metal surface with a few drops of 2½% silver nitrate sol'n. If tin is present, a black deposit with a white precipitate will form.

Test No. 6—Cupric Chloride Test: This test serves primarily to distinguish 18-8 and similar stainless steels from low-iron nickel-base alloys like Inconel. Place 1 drop of a 10% Cucl₂ in conc. HCl sol'n. on the alloy for 2 min. Add 3-4 drops of water, slowly, then wash off. The high-iron alloys will develop a copper-colored spot on the metal surface.

Spark Tests for Classifying Metals

Spark testing is an old and well-established method of classifying steels that has been used in steel mills and elsewhere for many years. In experienced hands, spark testing can be a very accurate—almost quantitative—method of identifying metals; even in less favorable circumstances the method can be a highly useful adjunct to salvage operations—particularly if a set of checking standards is prepared.

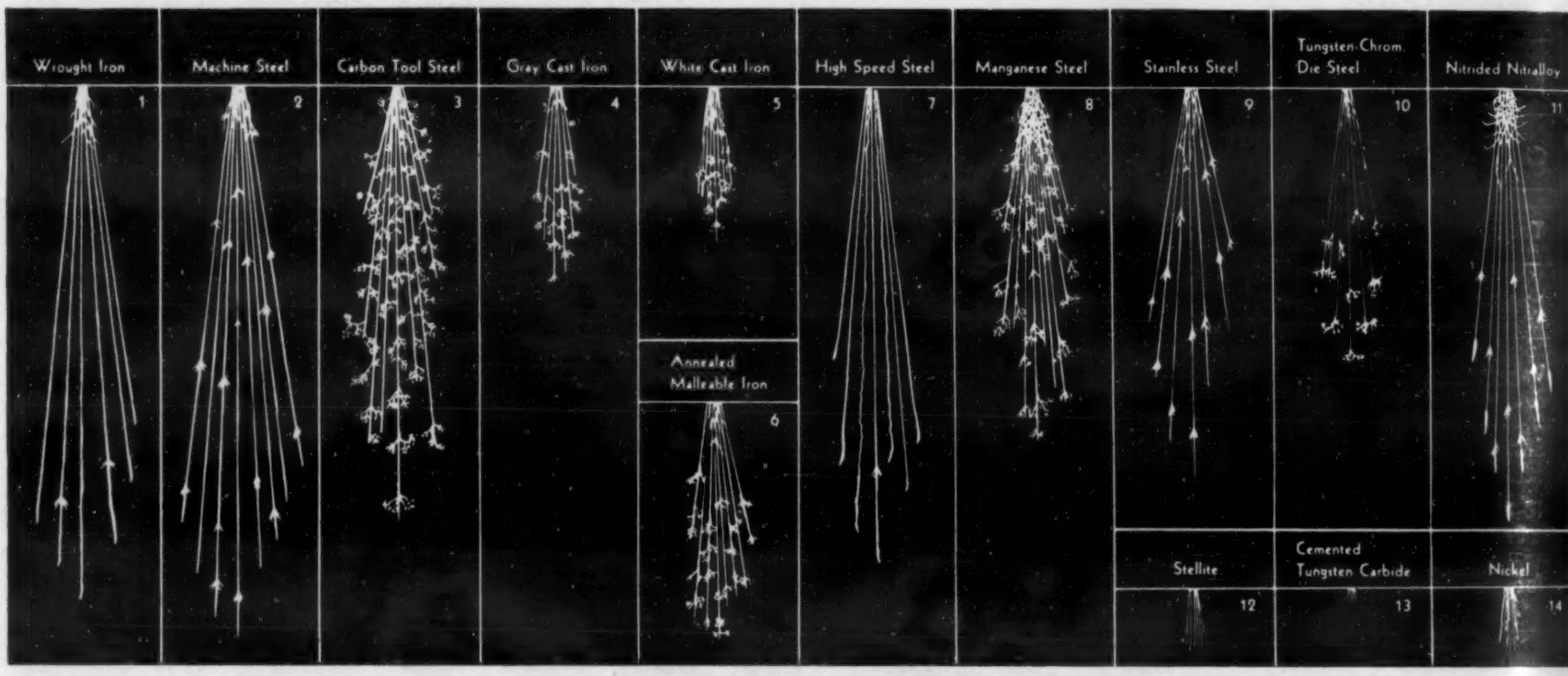
Spark tests should be made on a high-speed power grinder, with the specimen held so that the sparks fly off horizontally. The sparks should be examined against a dark background, and if possible, away from bright light.

The illustrations of typical spark streams given below can only reveal their fundamental characteristics and serve as a very general guide. For best results, the specimen in question should always be spark-tested in comparison with actual samples of known composition.

One of the most useful aspects of spark testing is its ability to identify tungsten steels—otherwise very difficult without making a chemical analysis. Tungsten imparts a dull red color to the spark stream, near the wheel; it also shortens the stream and decreases the size of or eliminates the carbon "burst." In 18-4-1 high speed steels, for example, the spark stream is long and thin, with dull red carrier lines. A 10 per cent W steel will have short curved orange spear points at the carrier ends. Further decrease in tungsten causes small white bursts to appear at the base of each spearpoint—so delicate as to be unmistakably different from those of plain carbon steels.

Molybdenum-tungsten high speed steels have orange carrier lines, in contrast to the dull red lines of the high-tungsten steels. However, the orange carriers are also produced by other elements.

Illustrations and Table reproduced through the courtesy of the Norton Company, Worcester, Mass.



Metal	Volume of Stream	Length of Stream, In.	Color of Stream Near Wheel	Color of Streaks Near End	Quality of Spurts	Nature of Spurts
1. Wrought iron	Large	†65	Straw	White	Very few	Forked
2. Machine steel	Large	70	White	White	Few	Forked
3. Carbon tool steel	Moderately large	55	White	White	Very many	Fine, repeating
4. Gray cast iron	Small	25	Red	Straw	Many	Fine, repeating
5. White cast iron	Very small	20	Red	Straw	Few	Fine, repeating
6. Annealed malleable iron	Moderate	30	Red	Straw	Many	Fine, repeating
7. High speed steel	Small	60	Red	Straw	Extremely few	Forked
8. Manganese steel	Moderately large	45	White	White	Many	Fine, repeating
9. Stainless steel	Moderate	50	Straw	White	Moderate	Forked
10. Tungsten-chromium die steel	Small	35	Red	Straw *	Many	Fine, repeating * Forked
11. Nitrided Nitralloy	Large (curved)	55	White	White	Moderate	
12. Stellite	Very small	10	Orange	Orange	None	
13. Cemented tungsten carbide	Extremely small	2	Light Orange	Light Orange	None	
14. Nickel	Very small **	10	Orange	Orange	None	
15. Copper, brass, aluminum	None				None	

† Figures obtained with 12 in. wheel on bench stand and are relative only. Actual length in each instance will vary with grinding wheel, pressure, etc.
* Blue-white spurts. ** Some wavy streaks.

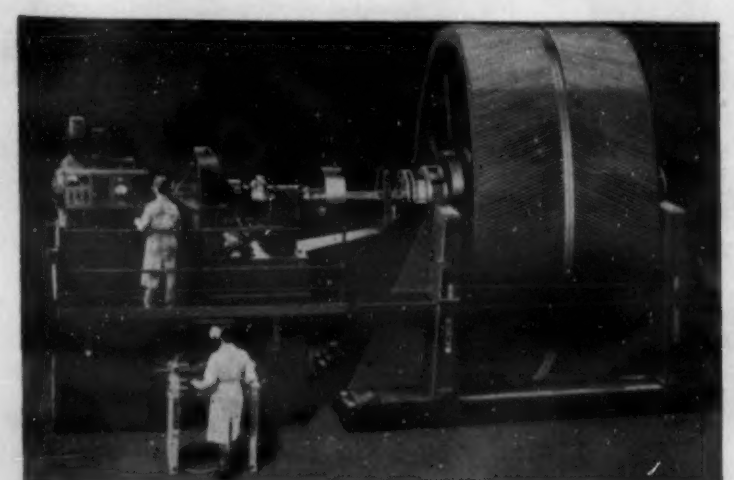
METALLURGICAL ENGINEERING news

Equipment • Finishes • Materials • Methods • Processes • Products
Alloys • Applications • Designs • People • Plants • Societies

Balancing Machine Range Is Expanded

The over-all range of the Dynetric balancing machine line has been expanded by the *Gisholt Machine Co.,* Madison, Wis., to extremes of 1 oz. and 50 tons. This has been brought about by two major developments.

First, the new Floor-Type Dynetric, built to balance parts up to 100,000 lbs. in weight, 240 in. long, with 200-in. swing, has passed all tests successfully and is now in use.



Second, Type S Dynetric, first to be manufactured and smallest of the entire line, can balance parts weighing as little as one ounce.

The machines are capable of correcting static and dynamic unbalance to reduce wear and prolong life in parts of any size.

No Nickel in New "Nickels"

New nickel coins which are presumably to be manufactured soon by the U. S. mints will have no nickel metal to conserve that critical metal for war purposes. Former nickels contained 25 per cent nickel and 75 per cent copper. Now, according to good sources of information, they may be made of equal parts of copper and silver—and manganese (perhaps 9 per cent).

The addition of manganese was a concession to the coin vending machine operators association who control nearly 3,000,000 machines. The former nickel coin had the proper high resistance towards electrical current influence to enable it to pass the monitor magnets used to trap spurious slugs. However the silver-copper "nickel," as first proposed, would present low resistance, become trapped and by-passed, hence fail to operate the machine and deliver the goods. A fair proportion of manganese offsets this.

It is understood that Armour Institute, Chicago, has been experimenting with and devising substitute "nickels."

Undoubtedly the new "nickels" will have the same thickness as the old since thickness is another means by which a coin-vending machine accepts or rejects a coin.

Additional refinements are incorporated in many coin-selling machines. In one design the coin, after passing the electrical resistance test, strikes an anvil and bounces back into the genuine or spurious metal slot, the quality of the metal to some extent influencing the bounce. Another refinement is the use of eddy-currents, whose swirling helps determine real from the false.

A Canadian nickel, which is 100 per cent nickel, is so magnetic it chokes the slot and mechanism, reacting differently from the standard American coin.

At one time it was found that nickels minted at Denver failed to act normally in coin machines. Upon analysis they were found off 2 per cent in standard metal content.

Few coin machines are absolutely slug-proof. During the depression the use of slugs was much more widespread than during more prosperous times. Machines operated by the Federal Government, such as mailers, are dangerous to tamper with because of drastic punishment, if caught.

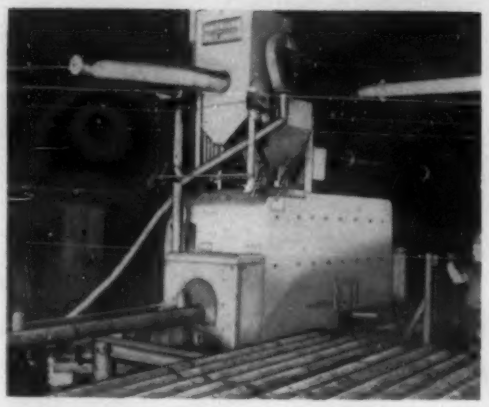
Tin was taken out of pennies early in February, the content having been 1 per cent, but now this has been reduced to a trace.

(More news on page 270)

Cleaning Pipe Inside and Out

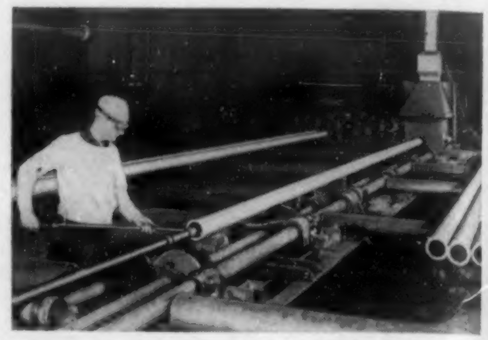
Under the heading of "A Pipe Dream That Came True," *American Foundry Equipment Co.*, Mishawaka, Ind., describes new methods and apparatus for cleaning seamless steel tubular pipe from heat treat scale. An airless Wheelabrator cleans the exterior, with an air blast for descaling the interior.

The process is rapid and, though no standards for speed have been set up, a cleaning production for 4½-in. low carbon pipe is being obtained at 18 ft. per min. for the exterior and 14 ft. for the interior.



A special cabinet housing two standard wheelabrator blast units cleans the outside. They are mounted in the cabinet bottom and blast upward and in direct line with the rotating pipe, passing continuously through on a conveyor. As the complete length enters the cabinet, another pipe is rolled into position for entry into the blasting area. After external work, it is rolled automatically off the conveyor onto skids, ready for internal cleaning. Conveyor rolls can be varied as to revolutions per min. and skew angle to be adapted to varying pipe sizes and diverse scale encrustations.

The air blast machine for the interior is near the wheelabrator cabinet. Cleaning



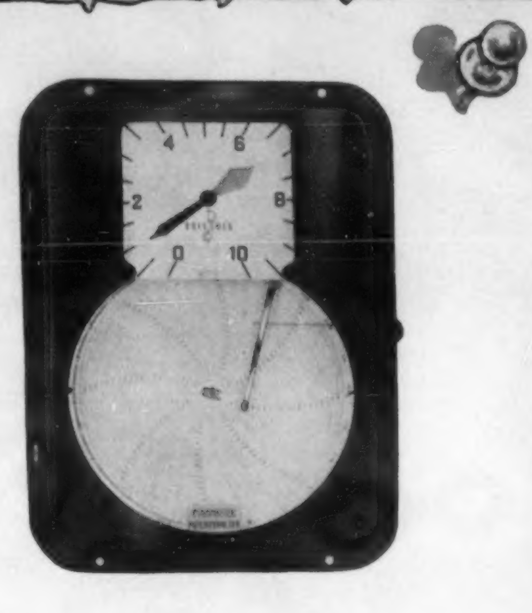
is done with a lance type blast nozzle long enough to blast the entire interior. The nozzle is placed into the end of the revolving pipe, which is supported on revolving steel discs. Pipe rotation and nozzle feed can be regulated. The air blast tank controls mixing of air and abrasive. This and storage hoppers are mounted on a car on a track, the entire mechanism riding forward, drawn by a steel cable.

A belt conveyor, under the cleaning device, returns the spent abrasive from the far end of the pipe to the elevator for recirculating.

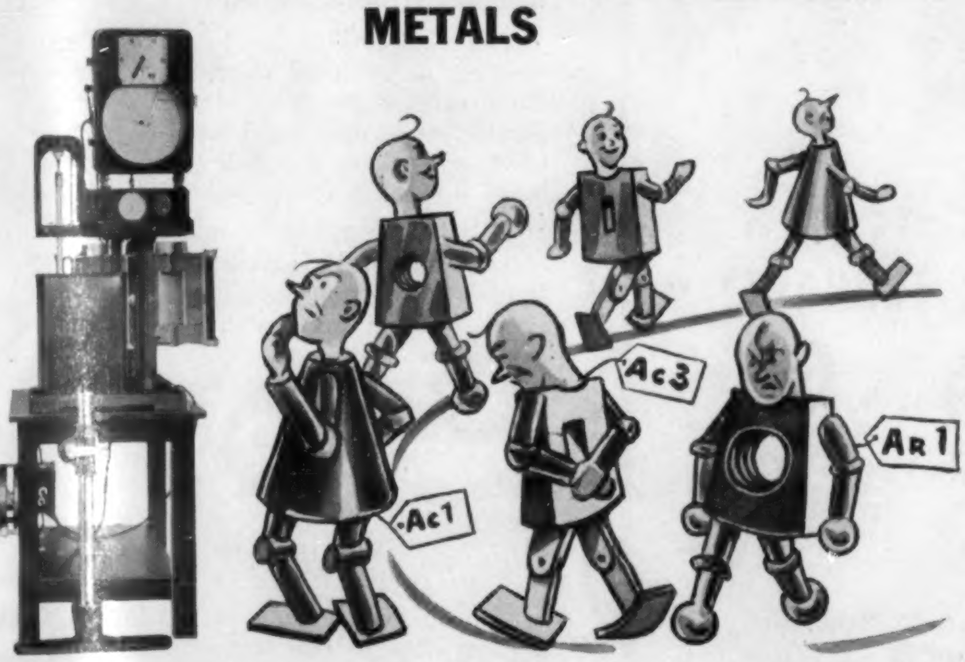
In the top photo, several lengths of uncleaned pipe are at the entry side. Pipe on the conveyor rolls has just entered the cabinet for external cleaning. The bottom photo shows the operator blowing out dirt from inside 5½-in. pipe preparatory to inserting the air blast nozzle. The metal housing at the far end serves as a hood for air removal to the dust collector and as a catch housing for spent abrasive to be returned by the belt conveyor.

New Alloy Cuts Hardened Steels

A new alloy material, available in drills, reamers and tool bits, is increasing production and cutting rejects in many metal working plants because it permits the full-hardening of steel parts before drilling, countersinking, boring, reaming and machining. This procedure insures accurately spaced holes and cuts, because any distortion caused by heat treatment occurs before work is done on the piece. It has also proved effective for work on armor plate, hard plastics and other hard materials such as amorphous carbon. The material is "Hardsteel," made by *Black Drill Co.*, Cleveland.



QUICK COMFORT FOR MISUNDERSTOOD METALS



From Sub-Zero to 2500°F., Bristol's Dilatometer Gives You Clear Picture of Criticals and Reversals

The Rockwell Bristol Dilatometer gives you a dependable indication and ink record of time-dilatation and temperature-dilatation changes *simultaneously* during heating and cooling cycles of ferrous and non-ferrous metals, ceramics and many other rigid materials.

Some companies report that the first test made with this Dilatometer revealed flaws that fully repaid the cost of the instrument. You may get similar *immediate* returns on your Dilatometer investment.

A Dilatation is plotted against both time and temperature on *one* conventional chart. No poring over photographs, no painstaking calibration. Sharp, clear dilatometric reversals give you exact understanding of metals classified by their actual heat-treating criticals.

Simpler to operate and superior in construction to foreign Dilatometers now impossible to obtain, this 100% American-made instrument needs no expert to run it . . . is highly practical for both production and laboratory use. *Write for Bulletin 546,* for complete details, addressing 114 Bristol Road, Waterbury, Connecticut.

TRADE MARK BRISTOL'S REG. U. S. PAT. OFFICE

GAS TOO LEAN? TOO TARRY?

Bristol's Pyromaster Controls Fuel In Producer Gas Machines

Absolutely uniform temperatures, and more economical output at *lower* temperatures, are made possible by placing Bristol's Pyromaster in charge of fuel bed depth in your producer gas machines. And when Air Feed & Saturation controls are added, even better results are obtainable — volatile contents higher, tarring troubles reduced.

Many plants have found that a Bristol Pyromaster pays its own way as a coal feed regulator when over-heated gases are too thin, over-cool gases too tarry. But why not get facts on the *complete* installation, controlling air feed and saturation as well as fuel? Write for detailed data on Producer Gas Machine Control.

TRADE MARK BRISTOL'S REG. U. S. PAT. OFFICE

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AUTOMATIC CONTROLLING AND RECORDING INSTRUMENTS

Any Idle Heat-Treating Equipment?

Because of a bottleneck in heat-treating equipment, the Aircraft Schedule unit, representing the air forces of the United States and Great Britain, requests that a survey be made of idle heat-treating equipment. Hence, please report any such idle equipment to the Heat-Treating Equipment Unit, WPB, Room 4520, Social Security Bldg., Washington.

Bradley Stoughton, Chief Heat-Treating Equipment Unit

Lessons from British Maintenance

Resourcefulness in maintenance of machine parts under much more adverse conditions than in the United States is shown by a recent study by the Society of Automotive Engineers of automobile and truck maintenance in England. Much of their technique can be applied to fields outside the automotive industry.

In overhauling pistons, worn ring grooves are turned out for oversize width rings. Worn or broken ring lands are welded solid and re-turned. Tin plating prevents seizure of cast iron pistons. Worn piston pin holes are bored and fitted with phosphor bronze bushings, or sometimes oversized by chromium plating.

For crankshafts, both chromium plating and metal spraying have been used. Some use standard undersizes before building up the crankshaft; others keep shaft to standard to eliminate undersize bearings. On camshafts, Stellite is applied, then ground.

Large valves have replaced smaller sizes. Sometimes stems are brought to standard size by chromium plating, and often guides are filled with bronze welding rod and rebored. Some valves are replaced with Stellite, as are tappets. Chromium plating has also been used on tappets and rocker arm shafts.

Clutch faces have been repaired by Stellite; chromium plating has been used on discs. Toggle levers have been electric welded. Nickel and chromium plating, also electric welding, are successful on transmission shafts and shifter forks.

To rebuild differential yokes, metal spraying is employed often, though some build up surfaces with electric welding. Sleeves inside differential cases have been built up by oxy-acetylene welding and bored out, with spring pads built up by electric welding.

Broken main leaves are converted into intermediate leaves where breakage has occured near the spring eye. Shackle pins have been chrome plated, though some have been machined down and fitted with undersize bushings.

Where ball or roller bearings have loosened in front wheel hubs, bronze welding has built up internal areas so they can be rebored. Some hubs have been chrome or nickel plated.

In front axles, chrome plating has built up king pins, or pins are machined down and fitted with undersize bushings, or ground down to standard undersize, then built up with welding material.

Axle shaft splines are built up and filled in with welding. Splines are then milled into the shaft so the driving face is of parent metal. They have also been built up with chromium plating. Keyways have been reclaimed with bronze welding.

Cylinder heads have been salvaged and leaks stopped by welding, metal spraying and cold welding. Welding and cold welding have been used on cylinder blocks. Valve seats have been built up by welding Stellite. Cast iron and aluminum crankcases have been welded. Minor cracking of blocks and heads has been cured with bronze welding.

● A new line of welding fluxes for both ferrous and non-ferrous metals is introduced by *National Cylinder Gas Co.*, Chicago. No. 1 is for welding cast iron, No. 2 is a cast iron brazing flux, No. 3 is a brazing flux for brass, bronze, copper, steel and malleable iron, while No. 22 is an aluminum flux for sheet, cast, wrought and alloys. On all four, precautions have been taken to reduce noxious fumes, bubbling and boiling. They have ability to adhere to hot rods in the proper proportion with reduced tendency to blow away.


SMOOTH FACES
FOR CASTINGS
TAM Zirconite super-refractory mold and core washes produce smoother surfaces and reduce cleaning costs
By resisting the burning-in of the molten metal, TAM Zirconite Mold and Core washes speed up output of good castings by reducing the number and time of cleaning and finishing operations. Available in three grades: Zirconite A has a melting point above 3775° F.; Zirconite B has a melting point above 3600° F.; and Zirconite C, for special uses, has a melting point above 3600° F. They are quickly mixed by adding to water, and can be applied by either spraying, swabbing or painting on cores and molds. Write for complete details, today.
TITANIUM
ALLOY MANUFACTURING COMPANY
Zirconite Wash was used on this 94,000 pound .30-.35 carbon steel casting—11'6" high 14' diameter. Of special interest is the fact that no nails were used in the facing.
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Tool Steel Exhibit

An exhibit commemorating the *Taylor-White* development of high-speed tool steels was recently built by *Bethlehem Steel Co.* and presented to the Smithsonian Institution in Washington.

In 1898, Frederick W. Taylor, well-known industrial counselor and the originator of the Taylor System of Industrial Management, and Maunsel White, metallurgist of Bethlehem Steel Co., carried out a series of experiments at Bethlehem, Pa., during which they discovered an entirely new type of tool steel. Their work led to a new art—high-speed turning and cutting—which was soon to revolutionize the entire machine tool industry.

The main feature of the exhibit is a small-scale reproduction of the original Taylor-White laboratory in Bethlehem, with replicas of their lathe, heating furnaces, heat-treating furnaces, and the optical thermometer constructed for this test, one of the first of this type used in metallurgical work. Some of the original tools made by Taylor and White, the stamp used for marking their products, and specimens of other tool steels of the period are also included.

The exhibit contains much factual data about the process, several books written by Mr. Taylor, and a copy of the slide rule for rapid calculation of cutting feed, speed, and depth developed by C. G. Barth, a prominent mathematician associated with Mr. Taylor for many years. Many interesting photographs are also on display.

● The well-known Johnson's wax has been adapted for use as a final finish over black oxidizing or blackening processes for steel. The waxes are hard, water-emulsion waxes, and they leave a dull dry corrosion-resistant finish; they are easy to apply, being dipped or sprayed, or dipped and centrifuged. They are made by *S. C. Johnson & Son, Inc.*, Racine, Wis.

Lead Base, Tin-Saving Alloy

A lead-base anti-friction alloy, which contains but 10 per cent tin, and for which it is claimed that it can be used for every class of bearings where high tin alloys are now used, is being made by *Graphitized Alloys Corp.*, 11 W. 42nd St., New York.

The lead is hardened with tin, copper, antimony, arsenic and cadmium, with nickel if desirable. By a special process colloidal graphite is added to the molten metal, which provides an additional lubricant.

Among the other advantages claimed for "GRAC" are: Lower coefficient of friction, longer life, stability through repeated meltings, lower operating costs, reduced possibility of running hot, sizing or failing, better preservation of an oil film, greater resistance to compression, easily handled, can be poured or cast centrifugally.

● When Axis war equipment is captured by the United Nations samples are rushed to metallurgists to determine whether new and better alloy steels are used—also to indicate what metals the enemy is running short of.

Misco heat resisting alloy sheet carburizing boxes combine long life with light weight. They are easier to handle, require less time to reach carburizing temperatures, and most important of all they conserve nickel and chromium, since the weight of a Misco sheet carburizing box is never more than 50% of that of a cast box of equal capacity.

☆ ☆ ☆ ☆ ☆ ☆ ☆ ☆ ☆

To Conserve Nickel and Chromium

use MISCO

HIGH TEMPERATURE ALLOY

SHEET WALL CARBURIZING BOXES

Misco Furnace Parts, Roller Rails, Chain, Trays, Conveyor Rolls, Carburizing and Annealing Boxes, Dipping Baskets, Cyanide and Lead Pots, Retorts, Centrifugal Castings

Michigan Steel Casting Company

MISCO
Heat and Corrosion Resistant Alloy

One of the World's Pioneer Producers of Heat and Corrosion Resistant Alloy Castings

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News of Metallurgical Engineers

Robinson D. Bullard, reclamation engineer, Bullard Co., maker of mult-au-matic and vertical turret lathes, Bridgeport, Conn., has been appointed technical consultant to the Industrial Salvage Section, Bureau of Industrial Conservation, War Production Board. He will assist in preparing a definite book on industrial reclamation.

Edward F. Moran, sales manager, X-ray division, Westinghouse Electric & Mfg. Co., which was recently moved from Long Island City to Baltimore, has been promoted to the post of assistant to the manager. He joined Westinghouse in 1935 as technical adviser to the X-ray sales department, having specialized in therapeutic radiation and later industrial X-ray. He was graduated from Massachusetts Institute of Technology in 1932.

E. J. Egan, Jr. has become metallurgist for the Ridgewood Steel Co., Cincinnati, having formerly been salesman for the Cincinnati office, Federated Metals Div., American Smelting & Refining Co.

C. W. Meyers, who has been assistant manager of the metallurgical department, American Steel & Wire Co., Cleveland, since 1937, has been appointed special representative in the aviation field, manufacturer's products division, sales department, same company. He will specialize in stainless steel, but deal also with springs, cables, controls, wires, etc. He was graduated from the Case School of Applied Science and the Harvard Graduate School of Business Administration.

Victor H. Lawrence has been made general superintendent of the Otis Works, Jones & Laughlin Steel Corp., Cleveland. He took civil engineering courses at Lawrence University; then finished his schooling in metallurgy at Carnegie Institute of Technology and the graduate school of the University of Pennsylvania. Since 1917 he has been in the construction, operation, engineering and metallurgical phases of steel manufacture with several companies, joining Otis in August, 1941.

James Allison, formerly of Billings & Spencer Co., is now chief metallurgist, Star Drilling Machine Co., Akron, Ohio.

Richard J. Tatousek has become assistant metallurgist, Railway Steel Spring Div., American Locomotive Co. at Chicago Heights, Ill.

L. W. Papendick has joined the research department of Lindberg Engineering Co., Chicago, having been assistant chief metallurgist, Northwestern Steel & Wire Co.

Maurice C. Fetzer has become research metallurgist with Carpenter Steel Co., having taught metallurgy at Pennsylvania State College.

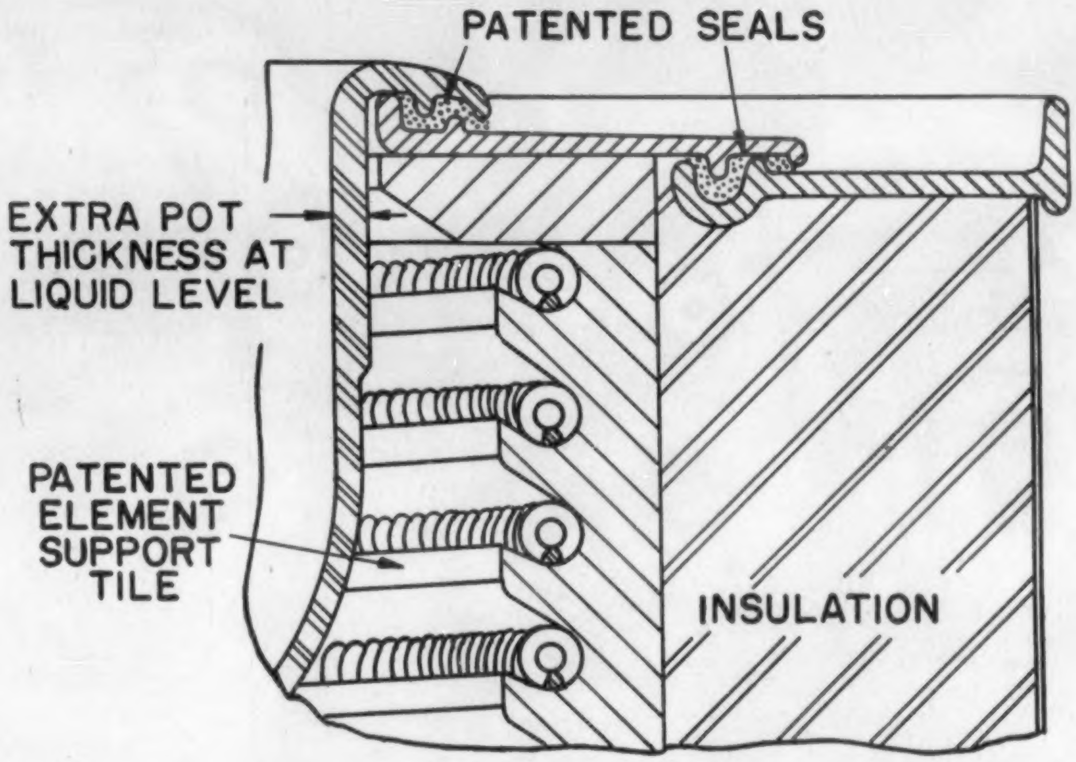
C. F. Quest heads the heat-treating division, Chattanooga Stamping & Enameling Co., Chattanooga, Tenn., having become a doctor of metallurgy at the University of Minnesota.

George I. Calvert, metallurgist, Emsco Derrick & Equipment Co., is on leave of absence to serve with the Ordnance department, Production Service Div., St. Louis Ordnance district.

Cyril S. Smith, research metallurgist, American Brass Co., Waterbury, Conn., now serves as research supervisor, War Metallurgy committee, National Research Council, Washington, D. C.

● The Otis Fenson Elevator Co., Ltd., Hamilton, Ont., has been granted manufacturing rights for Meehanite castings by the Meehanite Metal Corp., Pittsburgh.

THE DOUBLE SEAL AGAINST SABOTAGE



The "AMERICAN" Electric Pot Furnace with its Patented

Double flange pot
Double flange supporting ring
Double flange top ring

effectively stops the leakage and creep of salts and lead into the chamber of the pot furnace.

STOP this saboteur of these critical pot materials . . . .
Nickel and Chromium

Write for prices

Buy "AMERICAN"

AEF

American Electric Furnace Company

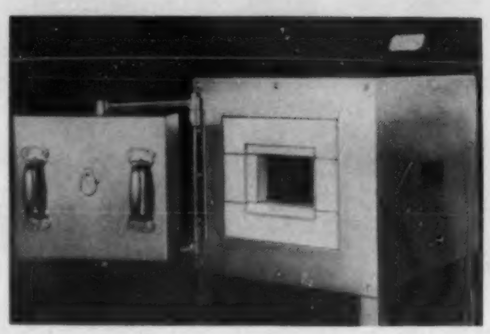
29 VON HILLERN ST. ★ BOSTON, MASS., U. S. A.
Industrial Furnaces for All Purposes

Electric Heat Treating Furnace

A full muffle electric box-type furnace, Falcon BWM, that is described as highly efficient for heat treating high speed tool steels, hardening, tempering and other applications, has been added to the line of *H. O. Swoboda, Inc.*, New Brighton, Pa.

Though designed primarily for fritting and glazing ceramics at temperatures up to 2000 deg. F., it is adaptable to steels.

Among the claims are low initial and operating costs, long operating life at maximum temperature. It takes less than an hour to reach highest heat.



Features are a center pivoted door, full box-type muffle and an all-refractory hearth. The hearth is completely surrounded by heating elements, to eliminate temperature variations in the hearth chamber.

It is available for bench or floor mounting, with capacity of 3 K. M., either 110 or 220 volts, single phase current.

● An acidproof brick-lined wood pickling tank, which releases steel for more vital purposes, has been developed by *Sauereisen Cements Co.*, Sharpsburg, Pa. The wooden tanks are lined with a cold acid-proof plastic, 3/4 in. thick for expansion and double-sealing. This lining and the exterior wood are both lined with protective hard-burned brick laid in modern silicate acid-proof cements. These tanks resist both muriatic and sulphuric acids and are in use in several steel plants.

Meetings and Expositions

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, Pacific Coast convention. Vancouver, B. C., Sept. 9-11, 1942.

AMERICAN CHEMICAL SOCIETY, semi-annual meeting. Buffalo, N. Y. Sept. 11-17, 1942.

NATIONAL PETROLEUM ASSOCIATION, annual meeting. Atlantic City, N. J., Sept. 16-18, 1942.

ASSOCIATION OF IRON & STEEL ENGINEERS, annual convention. Pittsburgh, Pa. Sept. 22-24, 1942.

SOCIETY OF AUTOMOTIVE ENGINEERS, National Tractor meeting. Milwaukee, Wisc. Sept. 24-25, 1942.

TECHNICAL ASSOCIATION OF THE PULP & PAPER INDUSTRY. Boston, Mass. Sept. 29-30, 1942.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION, annual meeting. Colorado Springs, Colo. Sept. 29-October 2, 1942.

SOCIETY OF AUTOMOTIVE ENGINEERS, Aircraft Production meeting. Los Angeles, Calif. Oct. 1-3, 1942.

ELECTROCHEMICAL SOCIETY, fall meeting. Detroit, Mich. Oct. 7-10, 1942.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, fall meeting. Rochester, N. Y. Oct. 12-14, 1942.

NATIONAL METAL CONGRESS AND EXPOSITION. Cleveland, Ohio. Oct. 12-16, 1942.

AMERICAN SOCIETY OF TOOL ENGINEERS, semi-annual meeting. Springfield, Mass. Oct. 16-17, 1942.

Simplicity Underlies Shop Improvement

A Westinghouse employee suggested that a machine be cut in two, making two machines, a suggestion put into practice, increasing production 50 per cent. A woman storeroom ledger clerk suggested that instead of aluminum castings of "standard size," from which Westinghouse made small lamp reflectors, the supplier furnish slightly smaller castings. This resulted in less scrap and hence saving of aluminum.

These were some of the recent results of this "Battle of Wits" among "ideaminded" workers which has been conducted for 32 years, saving $1,250,000 in time and materials. Altogether Westinghouse employees have offered 102,000 written suggestions, of which nearly one-third have been put into practice. During 1941 alone over 5,800 ideas were accepted. Checks ranging from $2.50 to $1200 have been paid employees for ideas.

As to the machine cut in two, Mike Ferry and a co-worker operated a machine consisting of a long table with a turret die or cutting tool at each end. Each operator placed a radiator section on which work was to be done on the table so that the turret dies could shape or flange the openings on one end of each section simultaneously. Then they turned the sections around to flange the other two ends. Many of these pipe-like sections were 14 ft. long and so unwieldy the operator of one cutting tool had to wait until the other finished before he could do his half. Ferry suggested cutting the machine in two, making each end a separate operation, so each man could work without interfering with the other.

Michael Dunn improved on a milling machine operation, which cuts grooves in steel transformer pieces. Cutting tools are similar to big rotary saws in lumber mills, but are made of sheets of tungsten carbide, so thin that they vibrated or "chattered" while cutting. Dunn proposed mounting pads of Micarta plastic to press against both sides of each saw. As a result a smoother cut, 30 per cent increased tool life and a higher speed resulted.

Albert Bachofer has been a machinist with Westinghouse for 41 years. He suggested a device to eliminate tool breakage and increase output of rotors used in electric power generators. He operates a cutting tool which grooves deep narrow slots in steel rotors for the insertion of copper windings where magnetism is created. Each slot is cut by moving the rotor back and forth for hours under the stationary tool. On the back stroke of the rotor the planer tool formerly was dragged through the fresh cut, causing friction, slower operations and often a jammed or broken tool. Bachofer suggested lifting the tool on the rotor's return. He was given $750. An automatic lift was devised.

Engineers who study suggestions submitted are impressed by the relative simplicity of the really good ideas.

● A new soldering flux, Solderux Cream, is intended for difficult joints and is especially suited to large masses that must be kept hot for a considerable time during soldering. It is good for joining very fine wires and delicate mechanical parts as it has little tendency to spread under heat. It is made by *Mico Instrument Co.,* Cambridge, Mass.

Metallurgical Engineers Wanted!

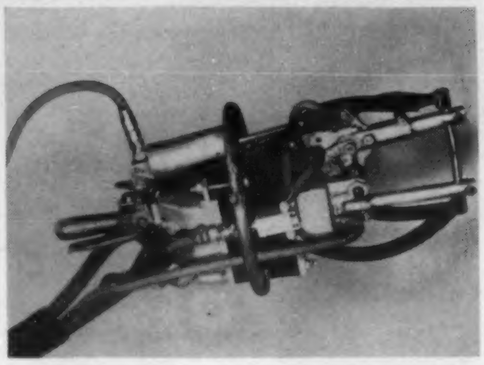
The U. S. Civil Service Commission is in urgent need of men with experience in all phases of mining and metallurgical engineering, salaries ranging from $3200 to $4600 per year. Vacancies exist both in Washington, and in the field.

Interested and qualified persons should apply under Examination Announcement No. U-173 for mining and metallurgical engineers. There is no written test. All applicants will be rated on the basis of their education and experience and other requirements set forth in the announcement.

Announcements and appropriate application forms may be obtained at any first- or second-class post office. Applications should be submitted to the U. S. Civil Service Commission, Washington.

● When the Kearny, big U. S. destroyer, was struck by torpedoes, the fact that she had two engines allowed her to reach port. Two engines were possible because of lightness due to alloy steel.

Flexibility in Production Spot Welding



Incorporating several unusual features, such as refrigerated electrodes, a standardized flexible installation for production spot welding of light-gage aircraft steels has been developed by *Progressive Welder Co.,* Detroit. Other features are variable throat-depth, transformer built into the gun and a jib crane with 6 ft. trolley type arm.

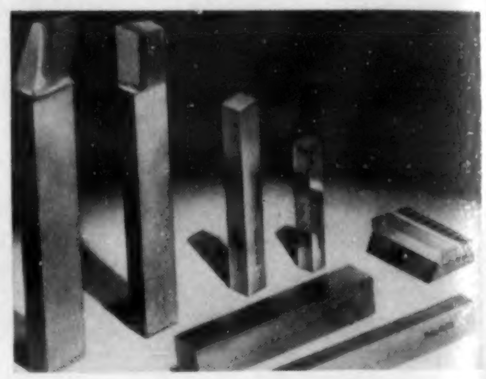
It is easy to install and provides a wide area for use, particularly for large assemblies or in combination with moving conveyors. The gun can be swiveled 360 deg. in any plane, facilitating welding in inconvenient spots.

Mounted atop the crane is a refrigerating unit which maintains the electrodes at below-freezing temperature, preventing mushrooming and deformation. A toggle level facilitates quick retraction of electrodes to clear obstructions.

● Radical redesigning of its Type R Wetherill cross belt magnetic separator is announced by the *Stearns Magnetic Mfg. Co., Milwaukee.* Much of the heavy framework which formerly supported the coils has been eliminated. Either a single magnet unit or several can be furnished. Ammeters can provide for accurate readings and regulate each magnet to a definite power or magnetic force, thereby effecting a clean separation.

Hard Alloy for Machining Steel

A new cobalt-chromium-tungsten alloy which increases speed of machining is called "Stellite" 98M2 and produced by *Haynes Stellite Co.,* 30 E. 42nd St., New York. The new tools machine steel at higher cutting speeds and with longer life between grinds.



Heavy roughing cuts with coarse feeds and long life are reported, for the alloy is well balanced in red hardness, edge strength and toughness.

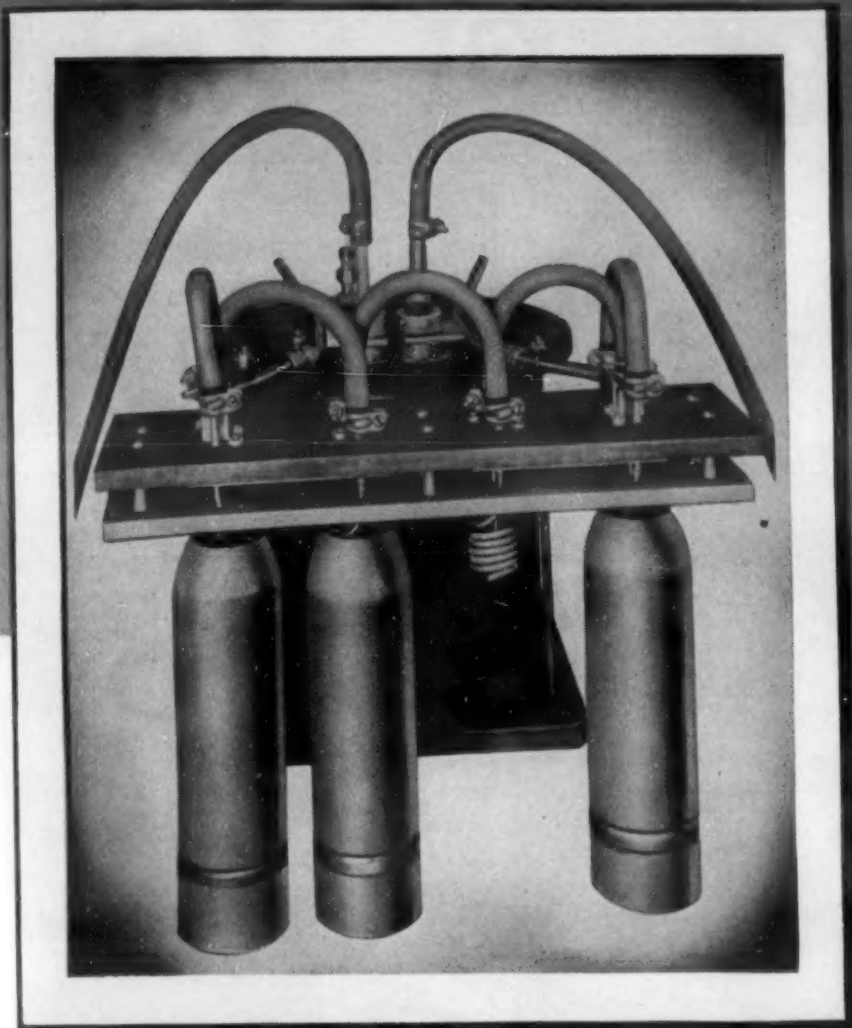
Such tools are reported to be making big increases in production of shells, aviation parts, tank parts, etc. They are available in standard square and rectangular solid bits and in 20 standard styles of welded-tip tools.

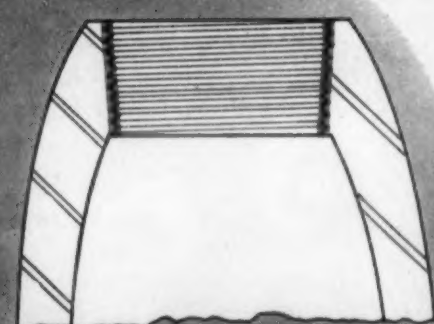
Automatic Spray Finishing

A robot painter that sprays automatically the multitude of parts that comprise Martin bombers has been installed by the *Glenn L. Martin Co.,* Baltimore. With it five men do the work formerly required of 15.

Made by a spray-gun manufacturer, numerous refinements have been added. One is the stack and ventilator arrangement which keeps fine paint particles from being drawn out through the stack into the air over the building, a fire hazard. Now excess paint spray is filtered through a veritable waterfall, collected in a tank, to be skimmed off with ladles. Two hand-spray booths on each cycle of the machine have been added.

Another *Thermonic* Achievement





IN THE modification of 75 m/m shells for a revised nose fitting, it was found that the tap and chaser life was exceedingly short. Investigation showed that the trouble to be caused by hardened shot from a shot-blasting operation lodging in the threads and interfering with the thread chaser action.

In order to relieve this condition it was necessary to heat the inside of the nose to annealing temperature without having the heat penetrate in the shell and change its physical characteristics. By having specially designed coils, one Model 1070 THERMONIC Induction Generator did this annealing operation at the rate of four shells in 50 seconds.

This is just another case where THERMONIC engineering and development came through with the answer to a difficult production problem.

A series of Data Sheets completely covering the subject of Induction Heating will be issued monthly. Nos. 1 and 2 are ready for you. Write to Department C.

INDUCTION HEATING CORPORATION

Designers • Builders • Of Thermonic Heat Treating Equipment

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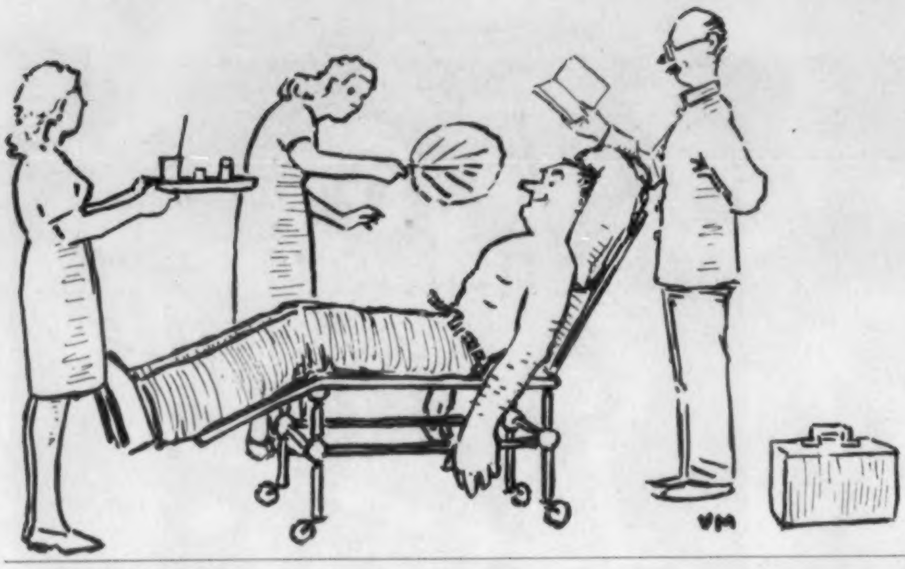


Be gentle with the worker, men, attend him when he tires,
And bring him salt and dextrose pills whenever he perspires.
Provide him books and movie shows and treat him hotsy-totsy,
We've gotta beat the blooming heat, to out-produce the Natzi.

—*V. McConnell*

Slants and Plants

"Fried potatoes can be enemy agents!" megaphones *United States Steel* to its workers. Neither does it use this vegetable as a figure of speech in the class with "small potatoes" or "spinach." It means just that in actuality.

In short, fried potatoes, at least in hot weather, cause indigestion, slower work and perhaps absence because of illness. The slogan is part of the "beat the heat" program carried on among 125,000 employees by means of motion pictures and booklets. Salt and dextrose tablets are furnished by the "corporation" during working hours to replace minerals and other body-maintainers. Good advice is furnished for the worker during his home hours.

Savage Tool Co., producer of the Doall surface grinder, in line with the government's policy to de-centralize industry, has removed its plant and office to Savage, Minn., from Minneapolis. A feature of the new factory is the completely equipped metallurgical laboratory for inspection and analysis of all materials entering the company's products.

A shipyard company which was disbanded in 1927, was reorganized in July, 1940. The yard was rehabitated at a cost of over $11,000,000, and the working force increased from 30 persons on Oct. 29, 1940 to 10,000 employees now. This is the brief history of the *Cramp Shipbuilding Co.*, Philadelphia. Officials predict that contracts for the Navy will be completed far ahead of schedule. Products are cruisers, submarines, fleet tugs and an extensive repair and conversion program.

Colonial Broach Co., Detroit, is occupying a new plant in that city which more than doubles its broach manufacturing capacity. Of one story construction, with two story offices, it was completed 90 days from start of work. The original building will be occupied by Colonial Bushings, Inc. and New Method Steel Stamps, Inc.

"Front Line Trenches Begin at Your Benches" is the slogan chosen from hundreds submitted by employees of Greenfield *Tapo Die Corp.*, Greenfield, Mass. At the plant's entrance is a glass-enclosed score board. Each day's output pushes the shell from an anti-aircraft gun closer to the targets—three planes labeled: Hitler, Mussolini and Hirohito. A direct hit consists of exceeding the week's production quota. Such a hit knocks one of the planes into the graveyard below. Rival plants strive for the first hit of the week.

(Continued on page 286)

Six days after a $2,250,000 fire at the Cleveland plant of the *National Bronze & Aluminum Foundry Co.* pouring of castings was being resumed. A new plant early next year will be producing aluminum castings for aircraft engines, employing over 1500. It will have over 200,000 sq. ft. of floor space and cost $3,000,000. Through revision of original building plans, 900 tons of steel has been saved. The new plant is that of the National Aluminum Cylinder Head Co., subsidiary of the company whose plant burned.

The manufacturing plant of the X-ray division of *Westinghouse* has been moved from Long Island City, N. Y., to Baltimore. Administrative offices had been transferred in January.

Brush Eliminates Stress Concentration

A power polishing brush, made of tampico fibre from Mexico, eliminates "stress concentration points" on metal surfaces and tends to prevent failures, particularly in airplanes where vibration is a destructive force.

These points may be only sharp scratches or nicks on the surface, perhaps not more than eight one-millionths of an inch deep. However, a stress, such as from engine vibration, often is concentrated there. Where

rough tool marks have been left, and not polished off, failures have often resulted.

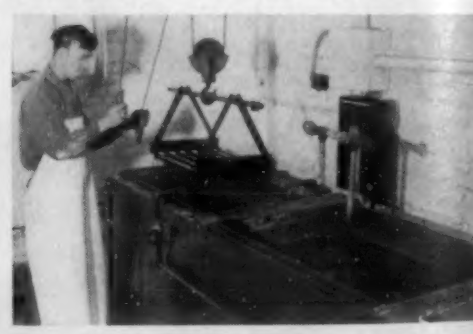
The tampico fibre brush, made by the *Osborn Mfg. Co.*, Cleveland, comes originally from the istle plant, similar to the yucca. The brush is treated with stiffening liquid to prevent fluttering.

● A heavy duty air-cooled arc welder for continuous mass production welding, known as the 250 F, has been introduced by the *Ergolyte Mfg. Co.*, Lawrence St. & Erie Ave., Philadelphia. This new machine reduces the thermal stress which strains the insulation on ordinary machines and shortens their lives. It handles electrodes from 1/16 to 3/16 in., has 24 heat steps, input voltage of 230 volts and a current range from 15 to 250 amp. It has a 60-cycle frequency and operates on a single phase or one phase of a two or three phase current.

Electric Heat for Cleaning, Rust-Proofing

Electric heaters are frequently used in tanks for cleaning and rust-proofing metal stampings.

The accompanying photograph shows the set-up at the *Bettcher Mfg. Co.*, Cleveland, where three General Electric 4000-watt,

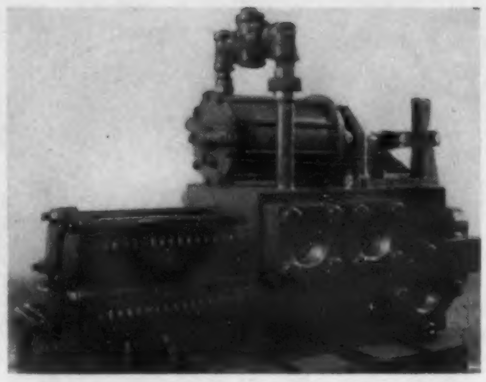


230-volt Calrod immersion heaters are used to heat each of four of their six tanks.

Stampings are conveyed from one tank to another by an electric hoist. Compressed air circulates the contents of the tanks, which are each of 95-gal. capacity.

● An Aridifier, used to clean the air or gas line of contamination, as made by the *Logan Engineering Co.*, Chicago, has conserved aluminum by using molded plastic rotors of black phenolic resin, there being 4 rotors in each Aridifier.

Valves for Shell Forging Presses



This 4-way quick acting operating valve is designed especially for forging presses. It is claimed that it prevents loss of high pressure fluid and minimizes any tendency to water wire drawing of the seats and spindles.

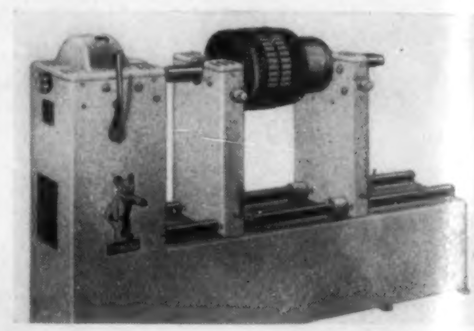
Designed and produced by the *Baldwin Southwark Div., Baldwin Locomotive Works,* Philadelphia, it has proved itself on many shell forging press installations as well as other hydraulic presses. It uses either air or hydraulic fluid, controlled by a small, easily operated auxiliary valve.

The valve has a forged steel body; spindles and seats are of alloy steels. Seats are removable for grinding or replacement.

● Motors suitable for use under magnesium dust conditions are announced by *General Electric Co.* These are polyphase induction motors, sizes 1 to 20 h.p., NEMA frames 203 to 326 inclusive. Since magnesium dusts are highly combustible, special motors in such surroundings are indicated. These motors are totally enclosed, non-ventilated in smaller ratings and a fan-cooled construction above 2 h.p. Simple cast-iron end shields, stator frames and fan housings make possible dust-tightness without complicating assembly or disassembly.

Industrial Balancing Machine

An industrial balancing machine series is available for all rotating bodies from 1 to 1000 lbs. capacity, made by the *Bear Mfg. Co.,* Industrial Div., Rock Island, Ill. The floor-type machine, model 370, pictured here, is available in three bed lengths.



The larger type will accommodate armatures, blower wheels, gears, pulleys, propellers, impellers, or other bodies weighing up to 1000 lbs., and having arbors or shaft extensions up to 3 in. in diam. Static and dynamic unbalance is checked simultaneously while the body is rotating. Floor models, a small bench model and a pit type are available.

Women Metallographic Technicians

Twenty-five carefully selected young women are due to be graduated on Aug. 20 from a course to fit them as metallographic laboratory technicians at Columbia University, New York. The training is consuming 60 hours of combined lecture and laboratory work, consisting of preparation of metallographic specimens by hand preparation methods, lead lap technique and electrolytic polishing.

Special techniques are taught, such as edge preservation, electrolytic etchings, principles of photography, photomicography and macroscopic photography.

The courses are given under the auspices of the Engineering, Science and Management Defense Training. Any potential employers of such women may contact G. L. Kehl, School of Mines, Columbia University, New York.

METALLURGICAL ENGINEERING

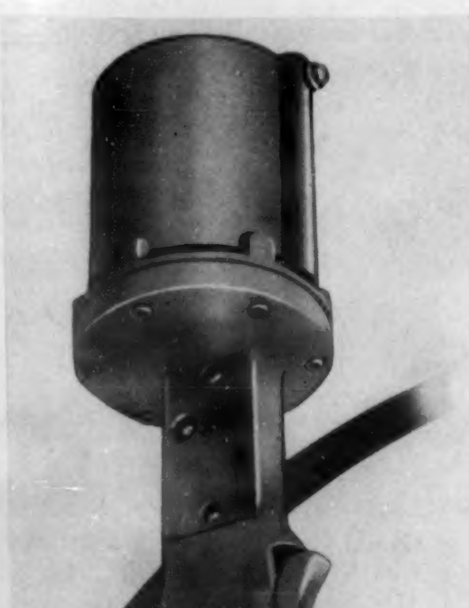
shop notes

Rivets as Blind Spot Fasteners

by Alex Mullgardt,
Cherry Rivet Co.

For use in blind spots where access to only one side of the joined structure is possible it is now feasible to use recently-introduced "blind spot" rivets. So far, they are employed primarily in the aircraft industry but may be adopted in other fields.

They are self-plugging rivets, having a mandrel with an expanded section and head on the blind side. This section is pulled into the hollow member, which pulling expands the shank and forms a tulip head in the back. The outside end breaks off during application and can be trimmed flush with ordinary nippers. Either a hand-operated or automatic gun is available.



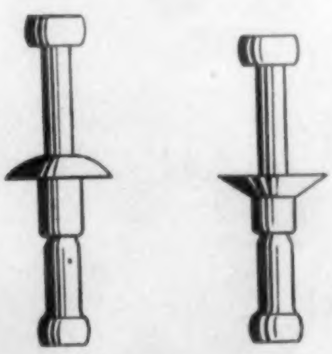
Such rivets, as made by the Cherry Rivet Co., Los Angeles, are of aluminum alloy, and they fill up the hole completely, no matter how inaccurate that hole. Several blind rivets available rely upon very accurate reaming of the hole to approximate a solid, rivet and are actually a modified bolt.

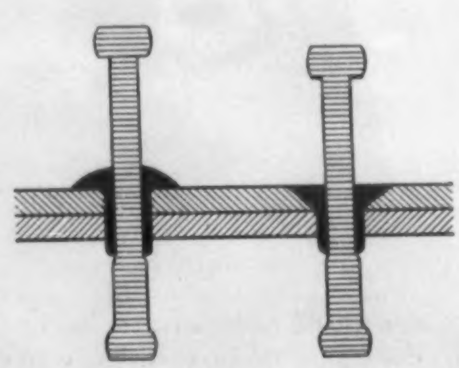
The feature of the Cherry rivet is its positive mechanical action. With a pull of 300 to 900 lbs., depending on rivet size, there is no doubt as to the strong head on the blind side. This type of rivet can be applied and trimmed at the rate of 540 an hour by one unskilled operator.

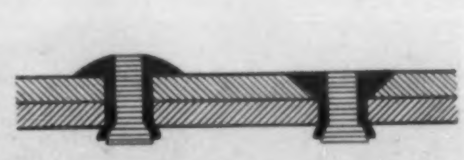
The force that breaks the mandrel also creates a clinching action, holding the sheets securely together, and expands the shank, causing a pressure fit. Resultant strength and resistance to fatigue compare favorably with the conventional solid rivet.

The number of blind rivet sites in a modern military craft ranges from 1,000 to 15,000. The tendency towards larger craft may increase need for blind riveting.

The accompanying diagrams show these "blind spot" rivet assemblies in both the brazier and countersunk types before and after the heading operation. Also shown is an automatic gun used to headup rivets. By pneumatic and hydraulic pressure, pull is exerted on the stem of the rivet, forming a head on the blind side.







(More Shop Notes on page 292)

Handling Heavy Metal-Cuttings

by B. B. Williams,
Cooper-Bessemer Corp.

Handling large single pieces of metal cuttings can often be done by mechanical means rather than by the gang's grunting and sweating and doing it by hand. This is the story of a simple eyebolt doing the trick.

Thus, at the author's plant a time and labor-saver was suggested by a workman in connection with the machining out of "windows" in the heads of large steel connecting rods for gas engines. The rod is a formidable piece of metal about 8 ft. long and 7 in. thick.

A very heavy piece of metal, sometimes a foot wide, is milled out of the rod. It is awkward to handle, since it usually drops out and has to be picked up again.

The new "wrinkle" was as follows: Before the machining operation is begun, an eyebolt is screwed into the metal so that it can be handled by a crane. When the window is machined out, the crane is hooked into the eyebolt and the heavy piece is easily carried away.

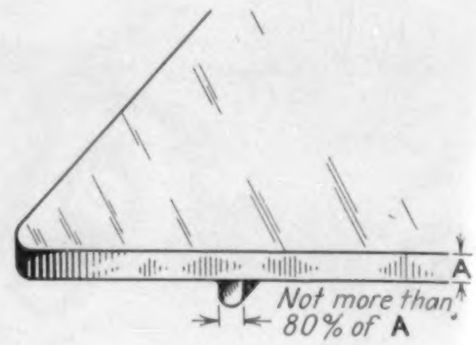
Designing for Die Casting

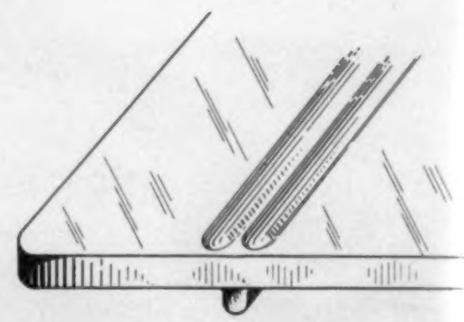
by G. L. Werley & R. E. Kellers,
New Jersey Zinc Co.

The following are some of the fundamentals in design for die casting zinc alloys to make for stronger product, allow for better subsequent finishing, and elimination of unnecessary metal and cost.

In casting plain flat areas without introducing difficulties in finishing, particularly plating, the "flat" portions should be slightly curved—or broken up by some simple design.

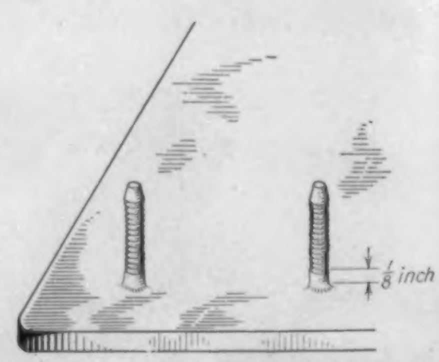
Shadow marks often show through on smooth surfaces of thin section where





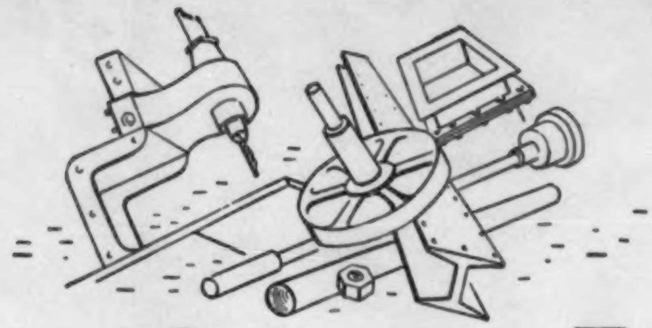
bosses, ribs or studs are used on the back. These can be avoided if thickness of the casting is kept above 0.100 in., or if the width of the underlying bosses, ribs and studs is kept to a maxiumum of 80 per cent of the wall thickness. If either method is impractical, some inexpensive external design will conceal the shadows.

Unthreaded studs as an integral part of the casting are preferable to inserted studs.



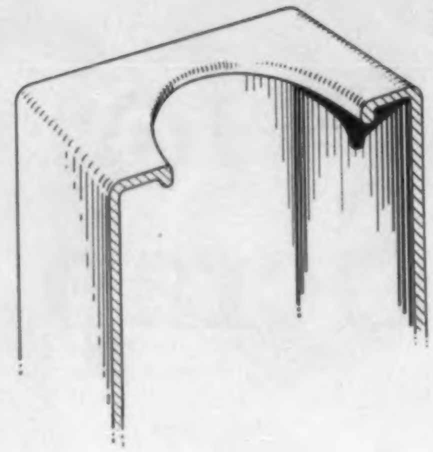
They should be at least 1/4 in. in diam., though on light castings smaller studs can be used. Plain studs are more practical than threaded, the latter causing expensive die construction and chasing of the threads. Speed fasteners are used advantageously on unthreaded studs.

Threaded studs can be strengthened by a fillet at the base, 1/8 in. radius. Also, 1/8



in. between the end of the thread and the base should prevail. Where inserted studs must be used, the thread must not extend closer than 3/32 in. to the casting.

Tapped bosses are stronger than threaded studs because external threads cause a notch effect in case of shock loads. With bosses, 1/8 in. must be allowed at the bottom of the tapped hole for chip clearance. A tapped hole should be countersunk 1/32 in. larger than the thread for ease of tapping and assembly.



Ribs should be added to thin wall castings for strengthening; they keep castings from deforming when hot and during trimming and other operations. Ribs or beads are often placed at thin sections where trimming is required and where the casting is to be gated.

Blind holes should be used where possible in place of a through hole.

Water for Hot-Strip Descaling

By Reginald Trautschold,

Engineering Consultant

The practical descaling of hot-strip, by water-spray impingement at a pressure of 1,300 lbs. per sq. in. at each of the mill stands, necessitates the employment of a water supply from which every trace of removable abrasive solids has been consistently abstracted. Otherwise, costly damage to the high-pressure pumping equipment ensues and, what is more serious, enlargement of nozzle openings with accompanying water wastage and reduced descaling efficiency of the powerful spray—the over copious water discharge causing excessive body cooling of the hot metal.

At one of the new tin mills where high-pressure descaling is employed with exceptionally good results, the raw cooling water, drawn from a large lake somewhat polluted with industrial wastes and sewage, is first forced through a bank of four Cochrane horizontal pressure-filters, each 8 ft. in diam. by 30 ft. in length, to remove all possible objectionable gritty impurities.

The clarified effluent is then fed to the heavy-pressure (1,300-lb.) pumping machinery, the needle-like spray from which breaks up and washes down every particle of plate-adhering scale and leaves the strip clean and smooth and at the proper rust-defying temperature—the scale and spent water passing with the run-off of low-pressure roll cooling water to a scale pit.

The mixture of descaling and roll cooling waters drops most of the scale in the pit, is then passed through mechanical strainers and re-used in further roll cooling service. The make-up for the descaling water supply is, on the other hand, freshly drawn from the inexhaustible lake reservoir and pressure-filtered.

The secret in welding manganese steel is time and lots of it—don't get it too hot. A case in point is repair-welding on the teeth of a 2-yard shovel bucket (the teeth are usually good for one week only). It is best to work on one or two complete sets of teeth at a time, changing from one tooth to another as they get warm. Used for the purpose is a manganese steel wedge-shaped bar, 4 in. wide and 2½ in. thick at the base. The teeth are squared and trimmed, welded with bare electrode and peened after each bead.

—*"The Stablizer"* Lincoln Electric Co.

Metallurgical Engineering Digest

FERROUS AND NON-FERROUS

1. Production

Blast Furnace Practice, Smelting, Direct Reduction and Electrorefining. Open-Hearth, Bessemer, Electric-Furnace Melting Practice and Equipment. Melting and Manufacture of Non-Ferrous Metals and Alloys. Soaking Pits and other Steel-Mill and Non-Ferrous-Mill Heating Furnaces. Steel and Non-Ferrous Rolling, Wire Mill and Heavy Forging Practice. Foundry Practice, Furnaces, Equipment and Materials. Manufacture of Die-Castings.

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Physical and Mechanical Property Testing and Inspection. Routine Control and Instrumentation. X-ray and Magnetic Inspection. Spectrographic and Photoelastic Analysis. Corrosion- and Wear-Testing. Examination of Coatings. Surface Measurements. Metallographic Structure and Constitution.

1 Production

OF METALS, MILL PRODUCTS, CASTINGS

Blast Furnace Practice, Smelting, Direct Reduction and Electrorefining • Open-Hearth, Bessemer, Electric-Furnace Melting Practice and Equipment • Melting and Manufacture of Non-Ferrous Metals and Alloys • Soaking Pits and other Steel-Mill and Non-Ferrous-Mill Heating Furnaces • Steel and Non-Ferrous Rolling, Wire Mill and Heavy Forging Practice • Foundry Practice, Furnaces, Equipment and Materials

CONTENTS

Hot Tears in Ferrous Castings

Condensed from "Foundry Trade Journal"

With steel castings, or malleable castings, the method of running and feeding in relation to disposition of mass and relative sections must be decided upon. In order to overcome liquid shrinkage due to initial freezing points and a short freezing range, top and side feeders may be used to provide reservoirs from which the casting can draw its supply of molten metal.

Pulling or "hot tearing" a defect which, although not wholly peculiar to malleable, is probably encountered more in the founding of this material than any other, calls for special consideration. While tearing in a radius may often be overcome by increasing the fillet, a "tie" or thin bracket of metal is probably the only method of dealing with hot tears around the periphery of a casting.

The elimination of internal tears, which may be caused by hard rammed cores, may necessitate considerable reduction in the bulk of cores, and in extreme cases a complete split through the core with its accompanying difficulties of registering and location. Any resistance to contraction from solid shrinkage must be minimized to prevent cracking or distortion.

Great care should be taken in locating cores in the mold, and again a simple jig or gage is of value, particularly with cores which have of necessity only a small print bearing as, for example, barrel cores located vertically.

During the discussion on this paper, venting foolproof sands, core-working difficulties, mechanical venting, molding machinery cause of scabbing, etc. were discussed. The author agreed that it did seem somewhat strange to say that, even with a supply of foolproof sand, venting was still required. He was convinced however, that much of the venting done today was carried out more from force of habit than from necessity.

—A. B. Bill, *Foundry Trade J.*, Vol. 67, Apr. 30, 1942, pp. 45-49; May 14, 1942, pp. 73-77.

Aluminum from Clay?

Condensed from a report of the Advisory Committee on Metals and Minerals

About 2 lbs. of alumina (aluminum oxide) of high purity are required for the production of each pound of metallic aluminum. Projected production of metallic aluminum in the United States is now 7 to 10 times the peacetime rate a few years ago. This great expansion was started for purposes of defense and was augmented for the prosecution of the war.

At the request of the Office of Production Management, predecessor to the War Production Board, a Committee for more than a year has been studying various methods of making alumina for the production of aluminum. Among others, several clay processes have been given careful consideration. The War Production Board has now asked our Committee to make recommendations, on the basis of these studies, for the production of

alumina from domestic raw materials and, in particular, to outline practical procedures for the production of alumina from clay.

Present Practice

In the past, all the alumina for the production of aluminum in the United States has been obtained from bauxite. Part of the bauxite was mined in the United States—chiefly in Arkansas—and part was imported from Dutch Guiana. All of it was chemically treated in the United States to separate the greater part of the aluminum oxide from the bauxite.

The chemical treatment was effected by alkaline solutions by a method known as the Bayer process. The ingredients of the bauxite other than alumina, such as the compounds of iron, titanium and silicon, constitute the tailings from the Bayer process operation. This product contains sufficient iron to give it a red color and hence it is called "Red Mud." Lime and soda, used in the processing, are also present.

Varying amounts of alumina remain in the red mud, depending upon the characteristics of the bauxite, the effectiveness of the treatment and, in particular, upon the amount of silica originally present in the bauxite. High-silica bauxites result in high alumina loss in the red mud.

Because of this relationship between the silica content of the bauxite and the alumina lost in the Bayer process treatment, there has been an incentive in the past to use low-silica bauxites. Much of the Dutch Guiana bauxite is low in silica and hence is a splendid Bayer process feed. In the domestic bauxites the silica content varies all the way up to 25 or 30 per cent.

The bauxites having a low silica content have been mined here for more than forty years to provide alumina for the production of aluminum and for other purposes. While some of the higher silica bauxite has been mined for chemical purposes, most of it remains in the ground.

Although there is no sharp dividing line between low-silica and high-silica bauxite, a few years ago an upper limit of about 5 per cent silica was used to distinguish Bayer process bauxite from high-silica bauxite. In recent years, however, material containing more than seven per cent silica has been used as Bayer process feed.

The alumina produced in the United States at present is made by the Bayer process. There are 3 plants: 2 operated by the Aluminum Company of America, and one by the Reynolds Metals Co. The effective operation of these plants depends on a supply of low-silicate bauxite. A substantial part of the low-silica bauxite used in the United States at the present time is imported from Dutch Guiana and must be transported by ship.

Now that the war is upon us and ships are being torpedoed in the waters between Dutch Guiana and the United States, there is not only a hazard in connection with the transportation of bauxite across these waters, but there is a possibility that the flow of Dutch Guiana bauxite to the United States may entirely cease. There being no known available deposits of bauxite in Canada, Mexico or other accessible foreign countries, it seems advisable to consider the steps necessary for the production of our entire alumina requirements from domestic raw materials. It may also be necessary to export some alumina to Canada.

Recommendations

The Committee's conclusions are summarized in the paragraphs that follow:

As a matter of insurance in the production of alumina, the WPB should consider the construction of lime-soda sintering plants in connection with the Bayer process plants. This would enable each Bayer process plant in the United States to operate on high-silica bauxite and it would also make possible the production of a portion of the alumina, in these combination plants, from clay.

The WPB should consider the possibility of recovering alumina from the accumulated red mud at the Bayer process plant of the Aluminum Company of America at East St. Louis, Ill. The amount of alumina in this red mud is equivalent to that in about one million tons of bauxite. This red mud is already mined and pulverized. *It contains a more favorable ratio of alumina to silica than obtains in kaolin clay.* It contains lime and soda, both of which would have to be supplied from new sources in the treatment of clay by the lime-soda sintering process.

The Committee considers a modified Pedersen process for the production of alumina from clay as the most promising process that will be independent of the Bayer process. This process consists essentially of sintering clay with lime and subsequently leaching with soda.

It is recommended that the War Metallurgy Committee be given the responsibility for the operation of the alunite and clay pilot plant near Salt Lake City. It is recommended that the Aluminum Co. of America be asked to prosecute vigorously pilot plant work on the lime-soda treatment of clay.

It is recommended, that the work now in progress on alumina at the College Park Experiment Station of the Bureau of Mines be continued, and that the War Production Board assist the Bureau in obtaining equipment for this work. A "Project Priority" for this alumina work is suggested.

It is suggested that the necessary amount of domestic low-silica bauxite, with other favorable characteristics for the production of certain abrasives, be earmarked for future abrasives production. It is also suggested that large quantities of bauxite could be conserved by restricting its use in the manufacture of aluminum sulphate. Calcined kaolin clay apparently can be substituted for the production of aluminum sulphate.

Because the best raw material for the production of aluminum is bauxite, it is suggested that the prospecting program for the discovery of new domestic deposits be prosecuted vigorously and that the known domestic deposits be appraised as to grade, tonnage and minability.

—Zay Jeffries, *National Academy of Sciences* Report to WPB, June 1, 1942, 8 mimeographed pp.

Wide Strip Rolling

Condensed from "Blast Furnace & Steel Plant"

The advent of the four-high, high-speed, strip mill in the 1920's started a trend which has led to the development of wide strip mills, both hot and cold, as the predominant system of rolling sheet steel.

Prior to the development of four-high continuous strip mills, various workers had attempted to mechanize the pack-rolling process by dividing the work among several roll stands and there arose out of this development a wide-spread belief, if not an outright insistence, on the part of steel men, that in order to roll with success flat sections which are very wide in relation to their thickness, the contours of successive "active" passes must be exactly controlled in their relation one to another, and specifically that the successive "active" passes must be of progressively decreasing convexity. By "active" pass contour is meant the shape of the pass when the metal is in process of being rolled. It is the same as the contour of the piece which it produces.

One theory behind the assertion just stated appears to have been that the metal under treatment is so wide and thin that its passage through the rolls cannot be controlled by side guides and hence that the shape of each pass must be so related to the profile of the piece which enters it that the piece will automatically "track" through the rolls, and that if the work-piece entering any pass was relatively more convex than the profile to which the piece was reduced by the action of that pass, the piece would automatically run straight and true and would not cobble.

If we assume that the piece to be reduced is originally convex, as would ordinarily be the case of a slab roughed down in two-high mills, or as would result from the first rollings on a sheet bar in a sheet or tin mill, the "decreasing convexity principle," as applied to such a work-piece would appear to be nothing more than an application of the ordinary principle of proportional rolling which is applied to the rolling of other sections.

Another theory which appears to have led to the belief above stated is that the reduction at any point across the width of the work-piece is reflected in a corresponding elongation, from which it would be concluded that the reduction ought to follow the stated procedure in order to insure commercial flatness and eliminate any tendency toward longitudinal shear.

The purpose of the investigation was to determine from a study of commercial rollings of wide strip mills of the four-high type whether it was in fact essential to successful strip rolling therein to employ a series of passes arranged in order of progressively decreasing convexity, or whether other relationships between successive passes might successfully be employed.

The investigation was limited to a study of hot mills. In cold reducing mills the factor of tension bulks so large that it would defeat the purpose of the inquiry.

The conclusion appears to be inevitable that there is transverse flow of the metal during rolling, even though there is no change in width.

The author's conclusions are:

(1) It is not essential to successful rolling of wide strip in continuous four-high mills that the active pass contours of successive passes shall be of progressively decreasing convexity. The convexity from pass to pass may increase, decrease or remain the same.

(2) So long as the active pass is substantially symmetrical about the center line of the strip, the strip will "track" satisfactorily through the mill. Deviation from the desired path may be controlled by side guides.

(3) If the reduction is not proportional across the width of the strip, transverse flow of the metal occurs.

(4) There are material deviations in thickness at the edges due to local action of the rolls and a more accurate determination of the rolling conditions may be made by measuring the thickness along marginal lines a few inches inwardly from the edges.

(5) Since all tests were run on four-high mills, which are inherently more rigid than two-high or three-high mills, the foregoing conclusions should not be assumed to apply to two-high or three-high mills.

—W. J. Blenko, *Blast Furnace & Steel Plant*, Vol. 30, June 1942, pp. 649-655, 661

Pouring High-Quality Steel

Condensed from "Steel"

Many melters or melting foremen consider their service ends as soon as the heat is in the ladle and they set about preparing the furnace for the next heat. But the quality of the steel going into the molds still remains their responsibility and their concern does not end merely because chemical specifications have been amply met.

The modern trend in ladle construction is toward the all-welded type. Low-alloy high-tensile steel used for this purpose allows a greater load of molten metal to be handled. While deep ladles still are used, the oval ladle is gaining favor.

Mold practice is highly important with the higher grades of alloy or S.A.E. steels. In fact the most essential features in the production of alloy grades include mold designs and their care, hot topping, speed and temperature of pouring and the use of antipiping compounds. With the more common grades including rimming steel, production does not necessitate the extra cost of special molds and pouring conditions.

Equipment

Rimming heats should be hot enough to pour free of skull. When too hot, rejections increase and mold and stool life decrease. There is no advantage in using the big-end-up mold for rimming, ordinary grades or even low-carbon killed steels; such molds, however, should be considered for the higher types of alloy steels.

Molds should be cleaned and sprayed, and used when warm. A few plants have a mold-warming oven for keeping molds at a definite temperature at all times. Some maintain that the temperature should range from 400 and 700 deg. F.

Another feature of importance is mold coating or washes which include graphite, tar and aluminum. Many plants using a solution of aluminum have found that it provides a smooth mold wash surface, lessening the effect of splashing and scabs and effecting some reduction of gases.

The cost of aluminum mold wash is roughly one to five cents per ton, depending on the amount of aluminum used and on the cost of the compounding constituent.

Some open-hearth shops use a tar dip which necessitates having the molds designed with a small radius at the corners, generally 1 in., so that the ingots will not develop corner cracks. Both the molds and tar solution must be at the correct temperatures. European practice involves asphalt mixtures. Many plants prefer spraying their molds with graphite containing a binder.

If these special mold washes are supplemented by using plates on the stools, scabs will be practically eliminated. The plates must be of light gage to prevent a reaction with the molten metal. When used with new stools they increase stool life by taking the impact of the steel stream on the initial opening of the nozzle, thus decreasing the "cutting" out.

Later when the stools are cut out the plates prevent extensive splash inasmuch as the stream hits the radius of the pocket and accentuates the splash. The knob is not eliminated because the molten steel soon burns through the plate but the plate prevents the initial splash and thus decreases scabs.

Pouring Practice

Pouring molten steel into ingots is a vital process in the manufacture of low-cost high-quality steel. The pouring temperature should be high enough so that the steel will pour clean, and the skull will not exceed 1000 lbs.

With proper deoxidation in the ladle, the analysis will show little variation, segregation will be normal, and the yield will be high. No aluminum should be added to the first ingot until the proper amount is determined.

The best practice with lower-carbon rimming grades is to shape up the heats hot and finish pour practically free from skull. Nozzle size naturally affects the pouring temperature and speed of fill. In a test involving 96 heats, 79 heats had no ladle skull, six had a 2000-pound skull, and four had a 3000-pound skull. These figures are offered as relative for the two sizes of nozzles.

At one plant pouring 160-ton heats it was found that the temperature differential from a heat free of skull to one having a skull of 15,000 lbs. was approximately 75 deg.

Heats that are bottom teemed are somewhat hotter than those that are top poured. However, the temperature of the metal is lower and the speed of fill slower for the same size molds.

The holding time, that is, the lapse of time from the completion of the pour to the beginning of the stripping operation, has an effect on the steel quality, the most important of which is the occurrence of minute laminations.

The usual pouring time for large heats is 40-45 min., which permits ample time for ingots to "set" but not to thoroughly solidify. With increased holding time the life of the molds is decreased and while there is an increase in mold cost this is more than compensated for by improved quality and higher yield.

—Paul J. McKimm, *Steel*, Vol 111, July 13, 1942, pp. 90, 92, 120-122.

A New Process for Aluminum Powder

Condensed from "Light Metals"

A novel method of commercial production of aluminum powder by use of the "flinger wheel" is described. The principle of the method consists in allowing molten aluminum to fall drop-wise on the rim of a rotating wheel. On striking the nobs on the rim of the flinger wheel, the drops of molten aluminum are broken up into small particles and are flung into the receiving chamber.

The larger particles settle more or less rapidly on the floor of the chamber, and are conveyed to suitable hoppers. The finer particles are recovered in a dust filter.

It is necessary to conduct the powdering operation in a neutral atmosphere, which entirely fills the sheet metal "rooms" in which the process is carried out. About

COKE OVEN FLUES AND BASE SLAB

BUILT WITH LUMNITE

HEAT-RESISTANT CONCRETE

• Important coke-plant use of LUMNITE — Refractory Concrete Door Lining. This picture shows a Refractory Concrete Lining after more than 5 years' continuous service.

THE picture shows a battery of underburner regenerative by-product coke ovens under construction. Arrows indicate waste heat flues made with LUMNITE Heat-Resistant Concrete. The same type of LUMNITE concrete was later used for the base slab of the ovens.

In the flues of the coke plant above, LUMNITE concrete eliminated the need for a separate refractory lining. This saved one material, as well as construction time.

Other uses of LUMNITE Heat-Resistant Concrete are for top-paving of coke ovens, for furnace foundations and floors subject to continuous high temperature.

LUMNITE Refractory Concrete finds wide use in coke plants for oven door linings, riser-pipe linings, precast gun blocks and flues. Any special shape may be made at the plant as desired. Rapid hardening of LUMNITE makes casting easy, and installation is possible the day after making.

IMPORTANT TO YOU—LUMNITE is obtainable today from building supply dealers throughout the United States. Heat-Resistant and Refractory Concrete are discussed in the booklet, "LUMNITE for Refractory Concrete." Write for your copy to The Atlas Lumnite Cement Company (United States Steel Corporation Subsidiary), Dept. M, Chrysler Bldg., N. Y. C.

LUMNITE FOR REFRACTORY CONCRETE

300 kg. of aluminum are poured into the holding pots at once, the pots being heated electrically. Six openings, 3-6 mm. in. dia., are present in the bottom of each holding pot, the exact size depending on the particle size of the aluminum desired.

The positioning of the aluminum holding pot with respect to the vertical axis of the flinger wheel has some bearing on the size and shape of powder produced. The minimum height of the holding pot above the wheel (the two are connected by a pipe through which the aluminum falls and through which the neutral atmosphere circulates) is 2 meters. The higher the pipe the smaller the powder particle size.

The flinger wheel itself is of steel 1 meter in dia. and 40 cm. wide, and mounted on a shaft in ball bearings. Straight transverse ribs up to 3 cm. high are used on the rim of the wheel. The optimum peripheral speed is said to be 60 m. per sec. Up to 100 m. per sec. (1,150 r.p.m.) has been used. The temperature of the molten metal naturally has an important effect on the metal powder. Raising the temperature makes the particles more flake-like; lower temperatures result in more spherical shapes. After 25-30 min., the flinger wheel must be allowed to cool, accordingly the amount of aluminum used is regulated so that the holding pot is emptied within this time.

The flinger wheel is placed in an air tight sheet iron spiral shaped casing (somewhat resembling that of a turbo blower) which is connected to one end of the receiving chamber, a sheet iron covered frame work of angles 8 m. long, 4 m. high at back and 1.8 m. high at front. Nitrogen is used for the inert gas, and is passed through a dust filter, and a cooler before it is recirculated into the powder chambers.

The powder obtained, while varying in size and shape as outlined above, is of the order of 5-30 mesh and coarser, hence is apparently not a competitor of ordinary aluminum pigment or other powders, where fineness of particle size is essential. It is used at present, it is understood, in preparation of thermite and as a starting material for aluminum pigment powder.

—*Light Metals*, Vol. 5, June 1942, pp. 197-201.

Cast Iron Crankshafts

Condensed from "The Iron Age"

Important properties of cast iron for crankshafts are: Tensile, fatigue and torsion strength; notch sensitivity, damping capacity, and wear resistance. The fundamental basis of high strength cast iron depends on the production of proper structure and the arrangement of graphite, pearite, and phosphide eutectic with minimum of free ferrite, cementite and minor inclusions, together with the control of the rate of graphite distribution on the cooling of the metal to a solid state.

The structure aimed at for Meehanite cast crankshaft material is produced by controlling the quantity of total carbon and a proper balance between combined and graphitic carbon contents in a matrix of fine sorbo-pearlite. Superheating and precise control over melting refines the graphite and grain structure, and final processing of molten metal in the ladle produces a structure having the highest physical properties.

The essential problems in making cast crankshafts are as follows: (1) Production of material with physical properties which will withstand fatigue stresses involving bending, torsion and combination of bending and torsion stresses; (2) Correlation of these properties to the section and design; (3) To insure that, design is modified to suit conditions of cooling and casting possibilities of particular design; and (4) Producing a casting economically and free from porosity and surface blemish.

Correct supervision is very essential. All crankshafts should be made in dried sand to assist the metal in filling the mold with as little temperature loss as possible. Dried sand molds offer better resistance to erosion effects of the metal and reduce sand wash. Correct trapping of slag with proper ingates, runners, etc. will further reduce loose sand getting into mold. Cooling of the mass should be uniform to avoid stresses within the casting.

An important advantage of the cast iron crankshafts is that they are free from distortion after casting. Irons of this class respond readily to heat treatment, by which tensile, fatigue and impact strengths can be increased as much as 25%.

—E. M. Currie & R. B. Templeton, *Iron Age*, Vol. 149, May 21, 1942, pp. 42-46.

2 Processing and Fabrication

FORGING, FORMING, MACHINING
HEAT TREATMENT, WELDING, FINISHING

Drop and Hammer Forging, Drawing, Extruding, Stamping and Machining • Age-Hardening, Annealing, Carburizing, Hardening, Malleableizing, Nitriding, Surface - Hardening and Tempering • Heating Furnaces, Refractories, Fuels and Auxiliaries • Welding, Flame-Cutting, Hardfacing, Brazing, Soldering and Riveting • Cleaning, Polishing, Buffing, Pickling, Electroplating, Galvanizing, Metallizing, Coloring and Non-Metallic Finishing • Die Casting • Powder Metallurgy

CONTENTS

Silver Plating as a Substitute

Condensed from "Steel"

Because of the availability, comparative ease of deposition, and attractiveness of silver, it will probably find increasing use as an electro-plated coating to protect steel against corrosion.

A cyanide bath is preferred commercially. A good solution for general plating contains 5 oz. AgCN, 7.5 oz. KCN, and 4 oz. K_2CO_3 per gal. It is used with 999 fine rolled annealed silver anodes at 65 to 85° C. Current-density is 2-15 amp. per sq. ft., depending upon the type of work being plated and whether or not agitation is used.

Some use sodium salts (which are cheaper) instead of potassium salts and claim that there is little difference in the deposits produced. The author's experience indicates that potassium salts results in better conducting properties of the bath, high solubility of the salts, better buffing qualities of the coating, and higher current-densities permissible.

Some Useful Baths

To obtain some of the better qualities of the potassium and produce a cheaper bath, it has been proposed to use a bath containing 4 oz. $AgNO_3$, 4 oz. NaCN, and 16 oz. KNO_3 per gal. Operating conditions are the same as for the first bath. The bath has many advantages and is commercially successful.

A bath containing 3 oz. $AgNO_3$, 70 oz. NaI, and 8 oz. $C_6H_8O_7$ per gal. is expensive but is used for producing a characteristic deposit on watch dials and similar articles. This bath is operated with 999 fine rolled annealed silver anodes at 70 to 80° F., with current-density of 3-10 amp. per sq. ft. Agitation can be used, and H_2SO_4 can be substituted for $C_6H_8O_7$. When plated work is removed, it should be rinsed in a concentrated iodide bath.

To improve the adhesion, the base metal is given a strike, and in some cases, 2 strikes, before being transferred to the ordinary bath. Solutions used contain 0.12 oz. AgCN and 9 oz. KCN per gal. and 0.4 oz. AgCN and 9 oz. KCN per gal. Carbon anodes are employed, a small silver area being used to replenish that deposited. Bath temperature is 70 to 80° C. Current-density is 15-25 amp. per sq. ft., with a 6-volt drop across the bath.

Instead of using a strike, it is possible to deposit a thin film of mercury on the base metal from a solution containing 1 oz. $HgCl_2$ and 5 oz. NH_4Cl per gal. There is some objection to using mercury because of the possibility of poor adhesion. The best method of obtaining good adhesion on cold rolled steel is to use a copper strike on the steel and follow with a silver strike on the copper. Highly polished steel surfaces appear to provide better adherence than rough finished steel.

Pore-free Deposits

Work of several investigators indicates that steel can be plated with a pore-free deposit of either copper or nickel which, in turn, is covered with a pore-free silver coat. As nickel and copper are hard to obtain, the author suggests that pore-free


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electrolytic iron be deposited upon steel as an undercoat for silver. He believes that such a pore-free deposit will be a substitute for nickel and produce a protective coating with silver even if the latter is only 0.0001 in. thick.

Electrolytic iron is suggested because pore-free deposits can be produced over electroplate easier than over mechanical surfaces of steel. Iron is cheap, easy to plate, and will take a silver plate. The deposit of iron should be about 0.001 in. thick and the silver deposit should be 0.0001-0.0003 in. thick to give good corrosion protection. There are no laboratory experiments which substantiate this, so that such tests should be made as soon as possible. The coating must be polished on an ordinary buffing wheel to obtain a lustrous finish.

Bright Deposits

A deposit approaching a bright plate can be obtained by adding extremely small amounts of carbon disulphide to the electrolyte. There is no better brightener than this. Resulting solutions should be agitated thoroughly. A stock solution of carbon disulphide can be made by adding about 0.25 fluid oz. to a solution containing 4 oz. KCN per gal. Even with this brightener the deposit must be buffed to obtain a highly lustrous finish.

A very recently announced method of electrolytic polishing of thick silver deposits uses a bath containing 4.3 troy oz. AgCN, 5 av. oz. KCN, and 5 av. oz. K_2CO_3 per gal. Bath is used at room temperature with slight agitation. Current-density is about 20 amp. per sq. ft. Silver can be used as cathode. About 9 min. are required to produce a polished surface.

Tarnishing of deposits can be prevented by coating them with a clear lacquer. They can also be protected for a time by producing a colorless thin chromate film over the surface.

Another method consists of producing a transparent film of hydrated beryllium oxide about 0.000,004 in. thick by making the silver the cathode in $BeSO_4$ solution and passing a current through for a predetermined time. Film should be heated to 275 to 300° C. for a few minutes to dehydrate it and make it more resistant to wear.

—C. B. F. Young, *Steel*, Vol. 110, Apr. 20, 1942, pp. 94, 107-108; May 4, 1942, pp. 91, 107-109.

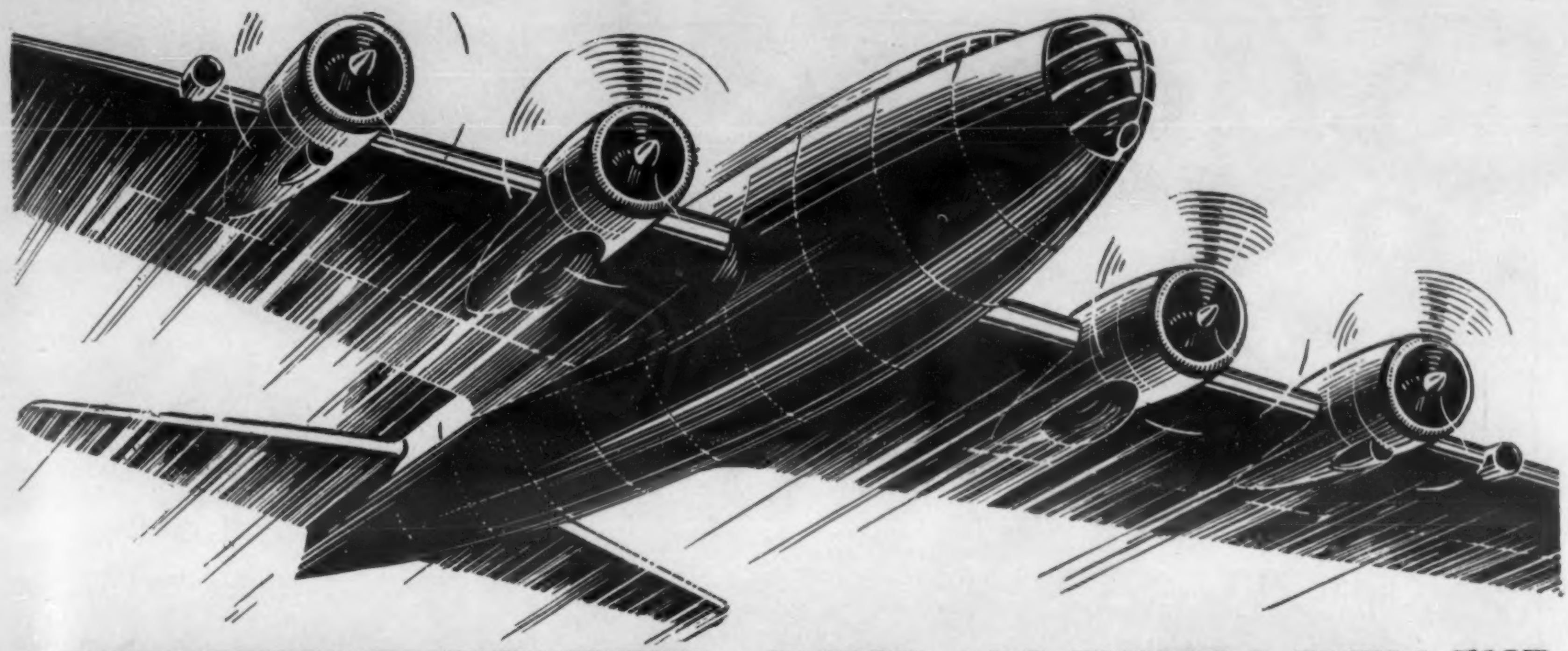
Oiled Black Coatings on Steel

Condensed from "Metal Finishing"

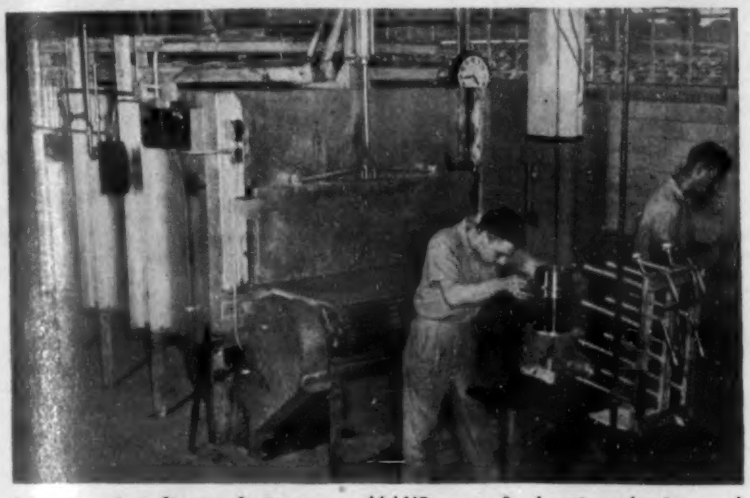
Black oxide coatings of any type will fail in less than 10 hrs. in the salt spray, but when coated with supplemental coatings of oil or lacquer, better protective value is obtained than with the supplemental coating alone.

An oiled oxide coating having a certain rating in the salt spray is not equivalent in protective value to a metallic coating having a similar rating, because an oiled coating is subject to injury by ordinary handling. Where an oil film is specified over a black oxide coating, it is frequently expected that the surface will be maintained by occasional oiling.

Since handling or wrapping may alter the



THESE ARE THINGS EVEN THE PILOT DOESN'T KNOW!



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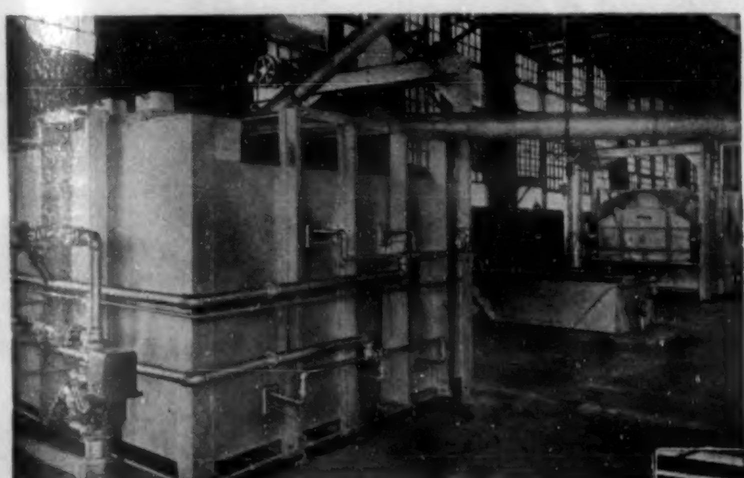

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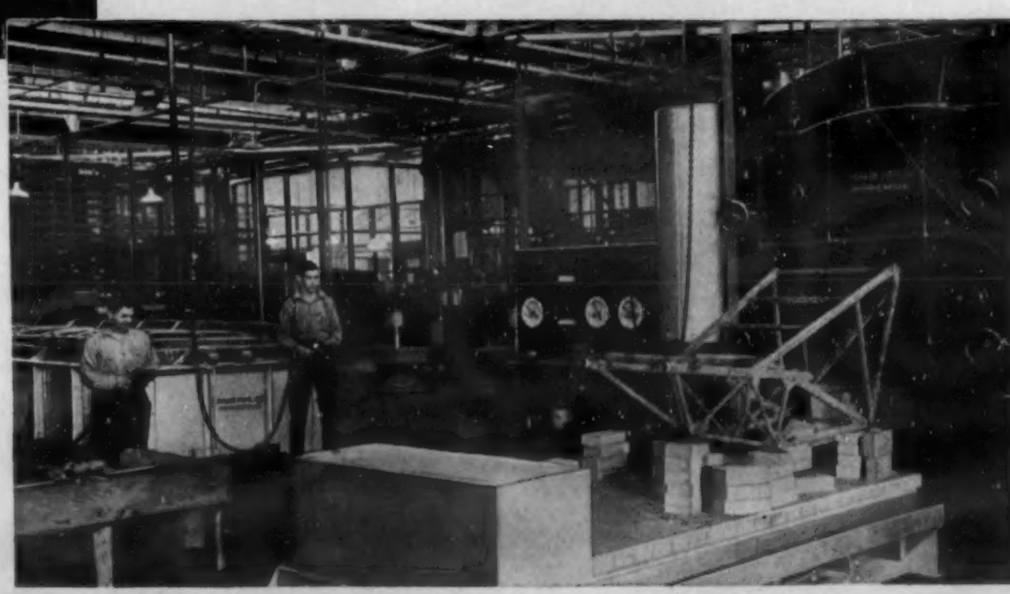


A corner of heat treating department in a large aircraft plant, showing MAHR stress relief and salt bath furnaces.

uniformity of oiled coatings, they should not be touched prior to or during the salt spray test. To obviate difficulties caused by non-uniformity of spray, from 4 to 8 duplicate samples should be distributed through the salt spray chamber, and each sample should have the same degree of inclination, as horizontal surfaces fail sooner than vertical surfaces.

The samples are evaluated by giving them a number indicating the degree of rusting. As salt spray ratings are not exact, it is advisable to have a standardized oil film to use as a basis of comparison.

—A. K. Graham, *Metal Finishing*, Vol. 40, May 1942, pp. 254-255

Heat Treating in Salt Baths

Condensed from "Canadian Metals & Met. Industries"

Two of the better known salt baths of the internally-heated, electric type are the Ajax-Hultgren and the Upton processes, each having its merits. Two methods are used in starting these furnaces. In one, carbon rods are placed between the electrodes in the empty furnace and then covered with salt. The electric current heats the electrodes to incandescence and the salt is melted.

In the other method, a pool of molten salt is made in the furnace with an oxy-acetylene flame, with the heating continued until the bath functions on its own. The necessity of maintaining the bath at 1200 deg. F. while not in use is one disadvantage. For intermittent operation the externally-heated oil or gas-fired types are efficient and economical.

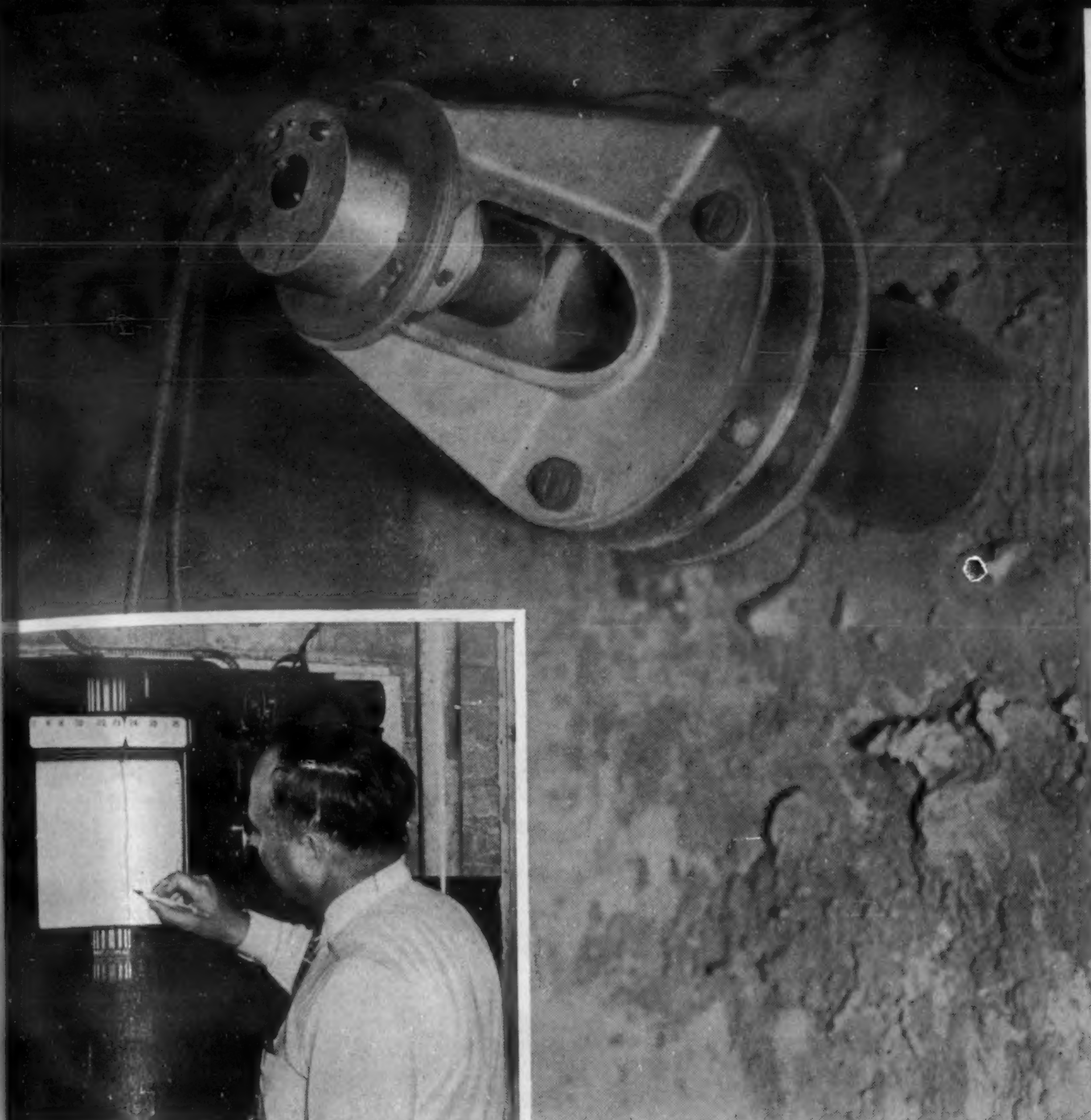
The file hardness obtained after water quenching cyanide-treated low-carbon steels is due to the action of the nascent hydrogen as well as the carbon from the cyanide. To produce case depth up to 1/32 in., activated cyanide baths are employed. In modern baths sodium chloride is widely used to govern the cyanide decomposition. The case so obtained has much more carbon and much less nitride than that obtained in cyanide alone.

These baths are characterized by their carbon top which prevents fuming, cuts down radiation, and prevents excessive oxidation of cyanide in contact with the air sweeping over the bath surface. A case hardened nickel-chrome steel stands up better under frictional loads than a similar low-carbon case-hardening grade, due to the fact that retained austenite work hardens readily under frictional loads.

The only apparent objection to the use of the alloy carburizing steels, especially those containing nickel and chromium, is that they require 10 to 20% longer time to produce a given depth of case. The wear resistance of malleable irons is greatly improved by carburizing in molten cyanide.

Work from an active bath should not be washed in water containing carbonate or phosphate cleaners as insoluble phosphates and carbonates interfere with cleaning. In operating any type of cyanide bath it is much better to add 1 to 2% of new material hourly rather than to add the total daily addition at once.

The effectiveness of the cyanide bath depends largely on continual oxidation of cyanide to cyanate, necessitating free flow



Rayotube, installed in furnace, is detecting temperature which Micromax Pyrometer, in insert, records and controls.

THERMOCOUPLES SCARCE?

Maybe Rayotubes Can Serve As Well — Or Better

At the time this is written, the conservation of metals has led to certain official restrictions in the use of the thermocouples, couple-protecting tubes, and leadwires which are accessories to pyrometers, in measuring the temperatures of furnaces, etc.

Before new thermocouples are needed, therefore, some companies may wish to see whether they can use Rayotubes where they have been using couples. We suggest this possibility because a Rayotube lasts for years where a thermocouple may last for weeks or months, with consequent saving of much critical material.

Probably Rayotube's usefulness as an alternate to couples is best shown by those applications for which they are not alternate, but are preferred, and have for years been used by thousands. Such applications include:

(1) Temperatures too high for couples; or so high couples don't last; or so high couples require excessive protection and are sluggish.

(2) Temperatures where furnace gases are too corrosive for couples.

(3) Temperatures of furnaces in which vibration breaks couples.

(4) Temperatures of objects in motion.

(5) Temperature of surface of an object, rather than of a furnace gas, when greater sensitivity of control is desired.

Rayotubes can be used for temperatures as low as 650 F in certain cases. They are completely at home from 900 F, up through and above the couple range, for indicating, recording and automatic control.

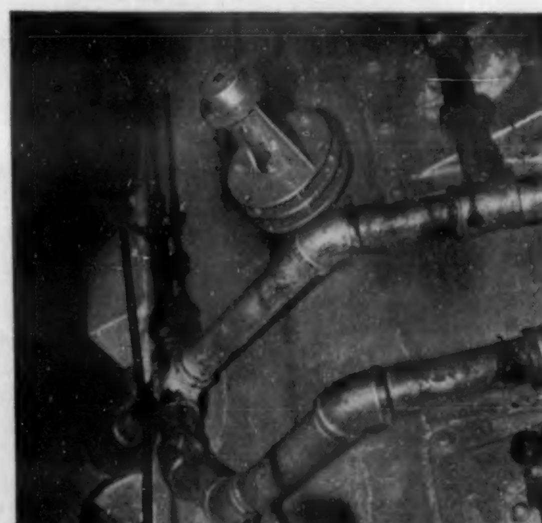
If you give us a specific problem, we will gladly tell you whether or not Rayotube can handle it, and recommend Rayotubes, thermocouples, or an Optical Pyrometer, as the case may be.

"Oh! Say Can You See!" is the title of this photograph which won, for Photographer R. W. Knauft, Sales Manager of Chas. Taylor Sons Co., first prize in Industrial Division of Ceramic Camera Club exhibit. It shows D. I. Smith using an L&N Optical Pyrometer in the Taylor refractories plant.

Optical Pyrometer Can Help Users of Other Pyrometers

Whether your plant uses thermocouples or Rayotubes to detect the temperatures which are regulated by its control pyrometers, it's almost certain that an L&N Optical Pyrometer can help in furnace operation. User simply looks through it at the hot work, turns a knob until a "bar" in the eyepiece seems to melt into the work, and reads the temperature in degrees. Readings can show difference between temperatures in different parts of furnace, between couples and work, etc.

Catalog N-33D gives further details; or, for special service, outline your problem and priority situation.



Pair of Rayotubes on a Stewart controlled-atmosphere broach-heating furnace; LaPointe Mach. Tool Co., Hudson, Mass.

Jrl Ad N-33-600(9)

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of air over the top of the bath. Any black scum forming on the surface of the bath may be eliminated by successive additions of laundry starch whereby scum is coagulated and is then easily skimmed off.

The cyanide content should be periodically checked and maintained between 10 and 25% for accelerated baths, and over 30% for the straight cyanide type. Weak cyanides may be disposed of by exposure in well-fenced waste ground, where in a few days the salt is converted into nonpoison carbonates. Another method is to dissolve the spent salt in water and precipitate ferrocyanide by means of ferrous sulphate. Quenching water should be cold and free from dissolved gases.

—R. C. Stewart, *Can. Metals Met. Inds.*, Vol. 5, May 1942, pp. 130-133, 139.

Finishing Aluminum Die Castings

Condensed from "Metal Finishing"

The mechanical finishing procedures described include polishing, buffing, "coloring," scratch brushing, ball burnishing and sand blasting.

A chemically produced frosted finish is obtained by dipping castings in a 15% solution of sodium hydroxide at 160 to 180° F. Following this dip the castings are rinsed, dipped in a sulphuric-hydrofluoric acid mixture, then rinsed with water.

An oxide coating may be produced by one of the "Alrok" processes. One of these processes comprises dipping the castings for about 15 mins. in a hot solution of sodium carbonate and dichromate. The oxide coating thus formed gives increased abrasion resistance, but is inferior to a good anodic coating.

The corrosion resistance of this coating may be improved by dipping in a hot dichromate solution. In cases where service conditions are severe, such a "sealed" oxide coating may be followed by paint or enamel.

Electrolytic Coatings

Anodic coatings are oxide coatings produced by making the castings the anode in a suitable electrolyte bath. Commonly used baths contain chromic or sulphuric acids (Alumilite Process). Alloying constituents in the casting may have a marked effect on the color, porosity, hardness, etc. of the oxide coating.

Anodic coatings can be produced which are porous and will absorb dyes, or such a coating can be given added protective value by sealing the pores in a chromate solution. Characteristics of the coatings produced on several types of alloys are described.

Electroplated coatings give ornamentation and may give increased abrasion resistance. Corrosion resistance is not usually improved by plating. The plating of aluminum differs from the plating of other metals only in the manner of preparing the aluminum surface, which requires special procedures.

In the acid etch procedure the work is dipped for 15 to 30 sec. in a solution of 3 parts nitric acid (sp. gr. 1.42) and 1 part 50% hydrofluoric acid. This is followed by rinsing and plating.

In the "Krome-Alume" process the cast-

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USE **PARK**

C. H. C. SALT M. P. 1100°—W. R. 1600°F. For intermittent bath or low "drag out" operation. Approx. 75% cyanide.

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KLEAN HEAT SALT M. P. 1160°—W. R. 1600°F. For "skin" hardening and reheat bath for carburized work. Approx. 30% cyanide.

PARK KASE #3 SALT M. P. 1050—W. R. 1700°F. An activated cyanide bath with incorporated carbon cover. Best suited for shallow "cases" up to .015″, or reheat bath. Non-fuming and soluble after quench.

PARK KASE #5 SALT M. P. 1200—W. R. 1700°F. Activated cyanide base salt. Very water soluble. For cases up to .010″.

PARK KASE #6 SALT M. P. 1150 — W. R. 1700°F. Activated cyanide base salt for "skin" hardness work.

FOR "HEAVY CASE" WORK
USE **PARK**

PARK KASE #1 SALT M. P. 1100°F — W. R. 1700°F. An activated cyanide base salt for case depths up to .125″, has incorporated carbon cover. Recommended for deep "case" work and long heating cycles. Cleans satisfactorily on quench.

PARK KASE #2 SALT M.P. 1040—W.R. 1700°F. Similar to PK_1 and will give case depths up to .050″. Has incorporated carbon cover. Cleans easily. Non-fuming.

PARK KASE ENERGIZER SALT A specially formulated cyanide energizer for addition to PK_1 or PK_2 baths, to maintain bath concentration for work with low "drag out."

PARK KASE CARBON A special carbon cover for addition to all types of "casing" baths to prevent fuming and reduce radiation losses.

PARK NO CARB A product applied to prevent carburization or decarburization.

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ing is anodized in oxalic acid and the anodic coating is then partially dissolved by treatment with sodium cyanide or hydrofluoric acid. A similar plating preparation consists in forming an oxide coating by an "Alrok" process, followed by a nitric acid dip. Nickel is commonly plated directly on aluminum. Chromium, copper, etc. may be plated over nickel to give any desired finish. Chromium may be applied directly to aluminum, but it is usually plated over nickel.

Painting and Lacquering

Aluminum die castings may be painted or lacquered either for decoration or for protection against a severely corrosive environment. For mild conditions, cleaning, preferably by solvent vapor degreasing, followed by slight roughening, *e.g.*, by sanding, will give sufficient paint adherence.

A more effective method is to treat the surface with a phosphoric acid solution. "Alrok" coatings, the "Pylumin" process, or anodized coatings provide still better paint adherence suitable for severe service conditions, such as continued service in high humidity atmospheres.

Following one of the above treatments, the castings should be dried to 30 to 60 min. above 212° F. and painted by dipping or spraying. The priming coat should have good adhesion to the base and should permit good adhesion of top coats. A zinc chromate primer is the best so far tested from the standpoint of corrosion resistance. Primers containing lead pigments should not be used as they promote corrosion in many cases.

Aluminum paint is both a good primer and a good finish coat. It has high impermeability to moisture and good adhesion. Since many finish coats are baked, the primer vehicle should withstand baking. Synthetic resin varnish vehicles are effective.

Where speed of drying is important, lacquer enamels of any color may be used. A primer which is not lifted by the lacquer solvent is necessary. Baking japans make a good black finish. If the natural aluminum color is desired, clear lacquers or synthetic resin finishes are satisfactory.

Cleaning

Castings may be cleaned for maintenance by the previously described caustic etch, by dipping in cold 1 to 10% hydrofluoric acid, cold 10% sulphuric acid containing 1% sodium fluoride, or in hot 10 to 20% phosphoric acid. These cleaners should not be used on castings of complicated shape or on Alrok or Alumilite coated articles.

Safe cleaners for the latter cases are liquid or paste waxes, most organic solvents, and soaps or alkaline detergents if they contain sufficient corrosion inhibitor such as sodium disilicate or sodium chromate. Chlorinated hydrocarbons are partially safe cleaners and must be used with care.

—A. E. Keskulla & J. D. Edwards, *Metal Finishing*, Vol. 40, Apr. 1942, pp. 220-227.

Silver Brazing

Condensed from "The Iron Age"

Silver brazing alloys are basically brazing spelter (60% Cu-40% Zn) modified by an addition of silver. Their melting points vary from 1175 to 1652 deg. F.

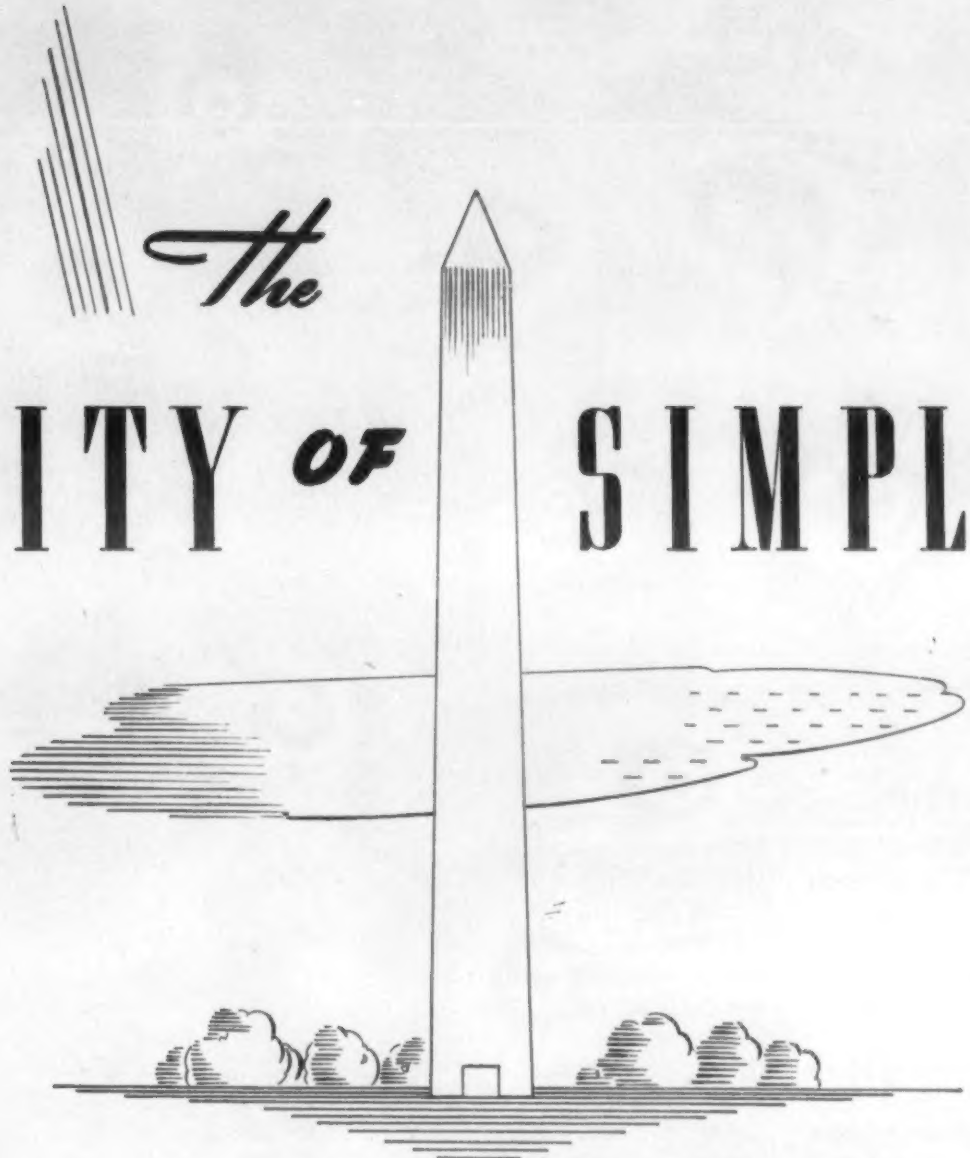
These brazing alloys should not be used as fillers or on "V" joints. Shear or lap-type joints are the easiest to braze. Scarf joints may be necessary in some cases to avoid lap joints. Sometimes butt joints are necessary; in such cases the surfaces should be machined square and even. Proper cleaning of surfaces is essential.

Brazing alloys require a flux except when brazing copper to copper with Silfos. For torch brazing, an alloy may be melted into joint from wire. When production warrants, preformed washers or rings of brazing wire are placed at the joint. This is necessary in furnace brazing.

A combination of oxyacetylene, oxyhydrogen and natural gas are commonly used for gas brazing. When using a torch heat is applied to parts away from the joint to bring both members up to the brazing temperature uniformly.

Metal bath brazing is a dip process wherein filler metal is obtained from a molten bath. This method is used for small work. The chemical method of heating requires that the assembled parts, with brazing alloy in place, be supported by jigs.

The induction method of heating is fairly new, and the advantage is quick, localized heating. It is applicable to non-magnetic



The DIGNITY *OF* SIMPLICITY

When an individual or institution appeals to the MIND, he comes with the DIGNITY OF SIMPLICITY. For truth is dignified and all things are simple. This is as true in manufacturing as in any other pursuit. ☆ Dramatic shows with slogans and gymnastics, may sway the emotions but frequently becloud the mind. They constitute SHOWMANSHIP—not SALESMANSHIP. ☆ Think of the time saved and losses avoided by the simple rule of putting castings under the X-ray for final inspection. Both the quality of the product and its performance may be enhanced by basing operations on factual truths and adhering to the FUNDAMENTALS OF SIMPLICITY. ☆ Those who perceive the true DIGNITY OF SIMPLICITY in the work of others, generally live and work in this manner themselves. And so we have faith in them.

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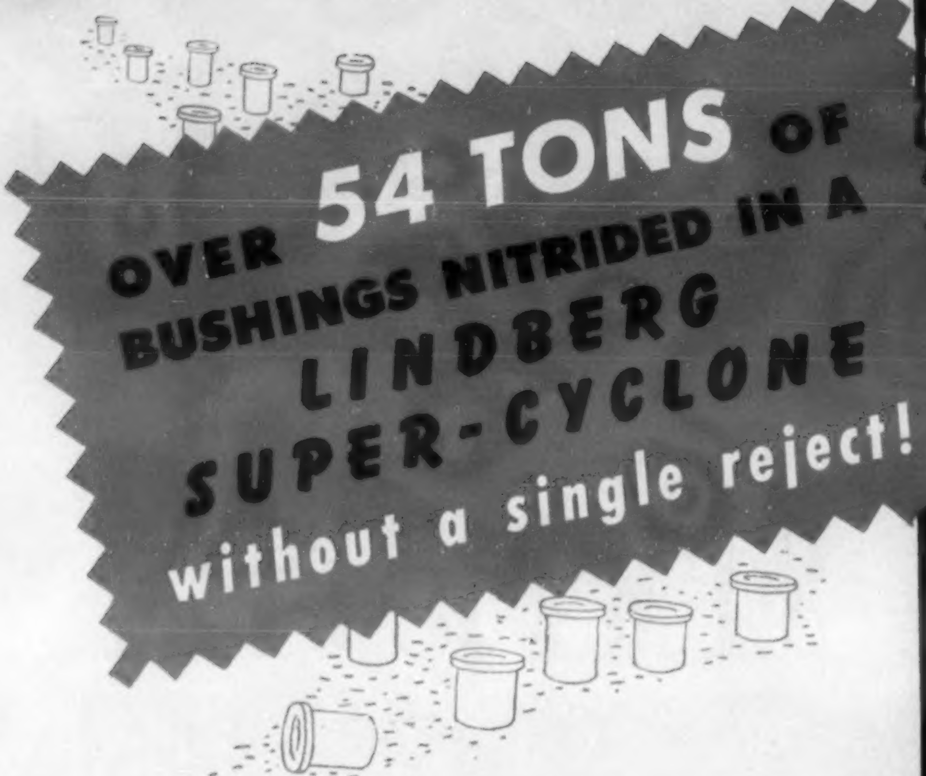

Over 54 tons of bushings have been uniformly nitrided in this Super-Cyclone without a single reject

A SUPER-CYCLONE is nitriding 3450 pound loads of bushings with uniform case and hardness in a large manufacturing plant in the Middle West. The bushings are 3¼" to 4½" in length and 1¾" to 3" inside diameter, with a maximum section of ¼".

A load of 1350 of the bushings are placed in a basket and charged into the retort of the Super-Cyclone where they are uniformly heated in ammonia gas for 72 hours at approximately 980°F. The parts have a .032" to .034" case depth and are never more than .002" out of round.

These results have been consistent since the Super-Cyclone's installation and to date over 50,000 of these bushings, more than 54 tons, have been nitrided *without a single reject!*

BUT WHY USE THE SUPER-CYCLONE?

Why not a low-temperature standard type nitriding furnace? The answer is that the same uniform job of nitriding could be handled in the Standard Cyclone Nitriding Furnace which has a top temperature of 1250°F., but this manufacturer, in obtaining the Super-Cyclone, looked further ahead than the job in hand.

In connection with the nitriding work, he can "cure" or denitride the retort by taking advantage of the high temperature range of the Super-Cyclone and, with the retort in the furnace, run the heat up to 1600°F.

A companion Super-Cyclone in the same plant is now employed for production hardening. After the nitriding job has been discontinued, he will have two 100% forced convection heated furnaces with temperatures from 250°F. to 1750°F. for hardening, annealing, normalizing, tempering, or any other heat treating operation which falls within that range.

Uniformly nitrided, this typical load of bushings has just been removed from the Super-Cyclone.

MANY ADVANTAGES

The Super-Cyclone, with its 100% forced convection heating principle and its wide temperature range, offers a variety of uses. In addition, it increases production through rapid, uniform heating of heavy loads, eliminates distortion due to uneven heating, reduces handling of material by employing a fixture to carry loads through all heating and quenching operations, and requires less floor space than conventional equipment to bring all these advantages.

Write for Bulletin 130. It gives more complete information on material handling, furnace operation, economy of floor space, sizes available and ways to figure Super-Cyclone production possibilities in your own shop.

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Write now to reserve a date for Fall and Winter showings of the full length sound and color Heat Treating Hints movie. Loaned without charge, this film shows actual heat treating operations going on with the editors of Heat Treating Hints at their furnaces, quench tanks and straightening presses. Each operation is thoroughly explained to the satisfaction of the greenest trainee. The film is purely educational and contains no advertising.

For your coming plant or chapter activities, may we suggest that you send today for the pamphlet giving complete instructions on how to arrange for the Heat Treating Hints movie.

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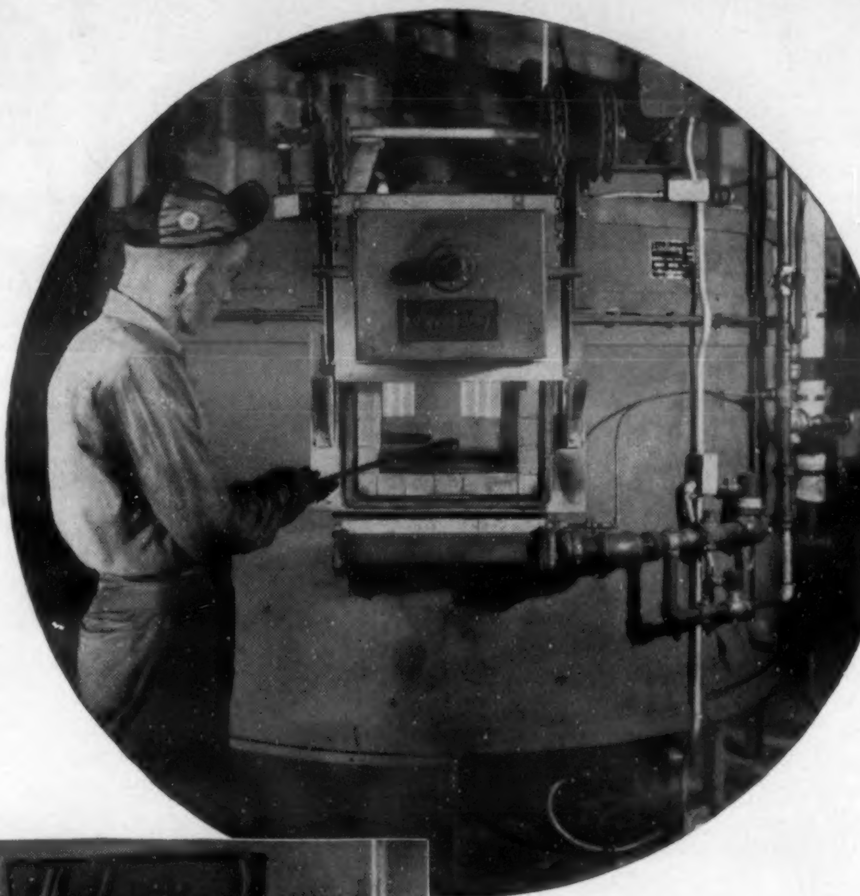
THE ROTARY HEARTH FURNACE



ABOVE: Every 3 minutes, 9 uniformly heated tool shanks are removed from this Rotary Hearth Furnace and 9 cold ones placed on the hearth, thus, setting up a steady production flow.

LEFT: A view into the work chamber showing elements, hearth, 9 pieces started on their 30 minute heating cycle, and the protective vestibule plate which prevents chipping of the refractory at the chamber opening. At the bottom of photo is the outside flame curtain burner. The flame is transparent blue and consequently does not photograph.

Every 3 minutes, day after day, nine 18 ounce tool shanks of alloy chisel steel are removed from a Lindberg Rotary Hearth Hydryzing Furnace, quenched in oil and nine cold shanks placed in the furnace. Thus, a steady production flow is set up—180 pieces per hour of scale-free, decarb-free and carburization-free work; over 200 lbs. of tool shanks per hour are uniformly heated and quenched with a resultant hardness of 58-60 Rockwell "C". They are then tempered in a Lindberg Cyclone Tempering Furnace for 1½ hours at 875°F.

ADVANTAGES OF THE ROTARY HEARTH

The application of the Rotary Hearth Furnace to this tool shank job is typical of its value in the shop where production hardening of parts, having similar weights and sections, is too great or inconsistent from a number of box furnaces and yet not large enough to justify a conveyor belt furnace.

The Rotary Hearth is, in principle, a small continuous type furnace with the advantage of requiring only one operator for loading and unloading from the same opening. The work is heated accurately on the revolving hearth by Lindberg Tubulaire elements that provide uniform heating throughout the work chamber and the fact that the speed of the hearth can be regulated to meet the heating needs of the steel, assures you of consistent production.

CLEAN HARDENING

When used with the well known Lindberg Hydryzing Process, the Rotary Hearth Furnace is ideal for the production hardening of scale-free, decarb-free and carburization-free machined parts. The neutral, controlled Hydryzing atmosphere turns out clean work that is full hard right on the surface and, being free of decarb, costly grinding, stoning or polishing operations are eliminated. The prevention of carburization lengthens tool and die life by giving a tough, hard surface that is free from cracking and chipping.

Lindberg Rotary Hearth Furnaces today are turning out gun parts, aircraft engine parts, ammunition dies, detachable rock bits, chisels, tools and dies, and filling the awkward spot in heat treating departments where the production of similar type work cannot be conveniently handled in box furnaces.

If you are confronted with this problem, write today and a competent Lindberg sales engineer will be glad to work it out with you.

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Whether the war has brought you into contact with heat treating for the first time or whether you have devoted a lifetime to it, Heat Treating Hints published without charge for heat treaters, offers you valuable "how-to-do-it" information on heating, quenching, straightening, etc.

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CYCLONE FOR LOW-COST ACCURATE TEMPERING

SUPER-CYCLONE FOR HARDENING, ANNEALING, NORMALIZING, TEMPERING, NITRIDING

HYDRYZING FOR SCALE-FREE AND DECARB-FREE HARDENING

as well as magnetic materials.

In resistance heating, the electric current is passed through the parts. Carbon block brazing consists of a transformer (5, 10 or 20 k.v.a.) and brazing tongs to hold the carbon electrode. Resistance welding machines may be used for brazing by means of thyratron control and tungsten electrodes.

The adaptation of furnace brazing to silver brazing alloys is new, and is used in brazing of high production small assemblies and large units involving many joints. In joint design a gap of about 0.003 in. is desirable when furnace brazing with silver alloys.

Stainless steel 18-8 can be brazed well with brazing alloy B 20 F 5. The temperature required to silver braze is in the carbide-precipitation range for this material, and therefore it is important to use columbium-bearing 18-8 stainless steel. In brazing copper with gas torch, or furnace brazing in reducing atmosphere, oxygen-free copper is used to avoid embrittlement.

—D. Basch, *Iron Age*, Vol. 149, June 4, 1942, pp. 62-63.

Oxy-Acetylene in War Production

Condensed from "Iron and Steel Engineer"

Old and familiar applications of oxy-acetylene welding are of greater importance today than ever before—such as repair of broken machinery, renewal of worn parts, installation of structures, machines and piping, alteration of equipment and demolition of useless items. Probably the most interesting and timely applications are in shell manufacture, shipyards and armor plate manufacture, which are distinctly war applications.

Shell - forging - slug - cutting requirements have led to the development of the multiple swinging-blowpipe type of cut-off machine. Control is by the simple rotation of a sequence switch. The cutting blowpipes assembled to the mounting bar operate in unison. Number of cuts depends on the camber of the billets being cut. Installations carrying five blowpipes on 14 in. centers are performing well.

Flexibilities of the oxy-acetylene cutting process make it adaptable to many shipbuilders' problems. Where formerly it was regarded necessary to use planers to prepare accurate edges for welding oxy-acetylene cutting equipment has now been adapted to work to required tolerances.

The principal new feature for plate-edging is the riding or floating support for the cutting blowpipe, which provides for waves and buckles in large-area plates, keeping a constant distance between nozzle and plate over the long cut.

As to armor plate, oxy-acetylene cutting is now accepted for most specifications and thicknesses, thereby expediting production. Procedures are similar to those in plain carbon steels save that cutting speeds are reduced slightly. However cut surfaces are left in a hardened and unmachinable condition.

One method, and the oldest, is preheating. Another involves the reheating of the cut plate either as a part of a subsequent heat-treatment or as a special tempering treatment to remove the hardness, this being employed today on tank armor.

A more popular treatment, fast and economical, involves reheating of the thin layer of affected metal adjacent to the cut surface by localized heat application, known as "flame softening." This is a tempering or drawing heat-treatment, restricted to the volume of metal which had been hardened to an unacceptable degree.

Two general types of armor plate are now employed regularly: Face-hardened and homogeneous. In the first, the plates are usually carburized to a depth of 20 to 30 per cent of the thickness to provide the carbon content necessary for extremely high hardness. Special heat-treatments are applied.

With homogeneous plate the composition does not vary from surface to surface and a uniform heat treatment is applied. Pilot tests have shown conclusively that ballistic resistance of such plate can be markedly increased through flame-hardening after pretreatment.

lame-hardening of armor for many applications, particularly tanks, is not far distant. Limitations are distortion of the plates and depths of penetration of the hardened zone. Flame-hardening may also be applied to cast armor, though no specified applications are yet adopted.

Oxy-acetylene is also helpful in the descaling of armor plate, particularly cast. It involves fairly rapid passage of the high-temperature, high velocity oxy-acetylene flames over scaled surfaces. The heated scale loosens and pops off.

—J. H. Zimmerman, *Iron and Steel Engineer*, Vol. 19, June, 1942, pp. 76-83.

Deep Drawing Aluminum

Condensed from "American Machinist"

Special hydraulic drop hammers can be used, but a punch press is preferred. With the Misfeldt method it is possible to draw aluminum parts 16 in. deep in a single progressive automatic operation. A single punch, die, and pressure plate is used. Since the drawing is done in progressive stages during one operating cycle of the press, the aluminum is stated not to work harden because stress limits are not exceeded.

The bed elevates the die against the punch, but each time the punch starts on its down stroke, the elevating motion of the die is stopped, so during the down stroke of the punch the material is worked to a point just past the yield stress. When the punch starts upward again, the die is elevated to its new position to await the next stroke of the punch.

This cycle is repeated until the punch has drawn the metal to the full depth of the die. A vital factor is the action of the hydraulic-pneumatic self-adjusting pressure pad cushion which maintains a constant pressure on the blank permitting it to flow uniformly around the punch and into the die without wrinkling or over-stressing.

The operation of this equipment is automatic. The speed of the draw is determined by the thickness of the metal and the shape of the part. In production, this depth is adjusted by a master valve which can be set on the basis of experience and experimentation for mass production.

—C. C. Misfeldt, *Am. Machinist*, Vol. 86, Apr. 2, 1942, pp. 285-289.

Free-Machining Steel

Condensed from "Modern Machine Shop"

There has been more information on machining in the literature of the past two or three years than was published in the ten years previous. In the field of steel composition the trend toward higher sulphur content to improve machinability is still very much in evidence.

During the past 20 yrs. average sulphur content of the fastest machining steels has increased from 0.100 to 0.400, a gain of 400 per cent. It will probably go higher. The trend is common to the United States and Europe.

Besides raising sulphur content of so-called screw stocks there is a tendency to resulphurize slightly low-sulphur carbon steels and alloy steels. Study has been given to sulphur compounds rather than straight sulphur, such as FeS, MoS, CuS, $FeSO_4$ and (NH_4) $2SO_4$. Compounds of sulphur and oxygen show considerable progress.

Sulphur may impart some anti-friction or anti-seizing properties to the steel. There may be a parallel between sulphur in steel and in cutting oil.

Though sulphur at present is by far the most effective agent for improving steel's machinability the trend of experimentation is with other elements. One of these is phosphorus, but we do not feel that this will prove to have a major effect in machinability similar to sulphur because it increases the strength factor too rapidly in proportion to its effect on ductility.

Nitrogen in small amounts increases brittleness without increasing the strength materially and seems to impart a higher degree of cold work embrittlement.

Lead has attracted wide attention. A lead content of 0.20 per cent in steel will give increased machining production of about 30 per cent. Physical properties are not materially affected by lead except when lead segregation (which is a real problem) makes the steel unsound. Heat treating operations will sweat the lead out of the surface of parts made from leaded steel and unless the parts are to be ground after hardening, this may render them unsuitable for use.

Investigation of machinability has not been confined to looking for some mystic ingredient to improve strength, toughness and shock resistance, giving also machining properties rivaling brass. Hot-rolling practice, annealing and other treatments are weighed.

—J. D. Armour, *Modern Machine Shop*, Vol. 15, July 1942, pp. 116-126.

3 Design and Applications

METALS, ALLOYS, METAL FORMS
ENGINEERING DESIGN, METAL SELECTION

Physical and Mechanical Properties (including Fatigue and Creep) • Corrosion and Wear • Engineering Design of Metal-incorporating Products • Selection of Metals and of Metal-Forms • Competition of Metals with Non-Metals • Specific Applications of Metals and Alloys

CONTENTS

Corrosion of Stainless Steels

Condensed from "Chemical & Metallurgical Engineering"

The development of the alloy steels containing around 18% Cr and 8% Ni and such other elements as colombium, titanium and molybdenum is discussed. The necessity for balancing of the composition so as to retain a completely austenitic structure at room temperature is emphasized.

Only single-phase austenitic alloys can be completely stabilized. If a ferritic phase is present in the alloy a transformation occurs when subjected to temperatures between 800 and 1600 deg. F. The new phase that appears is sometimes referred to as "sigma." In the attempt to balance the austenitic chromium-nickel steels containing columbium and molybdenum the most effective molybdenum content was found to be approximately 2%.

Chromium-nickel alloys containing 2% and 3% Mo with and without columbium are being tested in various plant processes under highly reducing conditions. The preliminary results indicate that the corrosion resistance of the alloys containing 2% Mo is as good or better than that of the alloy containing 3% Mo. The carbon content of these steels was 0.08% maximum, and the columbium 7 to 10 times the carbon content.

—Geo. A. Sands, *Chem & Met. Eng.*, Vol. 49, May 1942, pp. 132-135.

Steels for Plastic Molding

Condensed from "The Iron Age"

Successful plastic molding depends upon the design and quality of steel molds. Molds must operate at temperatures from 300 to 360 deg. F. and pressures of 1000 to 5000 lbs. per sq. in.

Mold steels may be attacked by (1) Sulphur in the plastic material; (2) Products of decomposition such as hydrochloric acid. Chromium plating has helped in some cases.

The types of molds are flash, semi-positive and positive. In semi-positive or positive molds, the upper force will rub against the side walls of the chase. This may be alleviated by reducing the punch dimensions by undercutting ¼ to ½ in. back from the mold surface, and secondly having steeper taper on the punch than the chase.

Flash molds have their greatest wear on landing pads which arrest downward movement of the punch. Consequently flash line may increase from a desired thinness of 0.002 to 0.003 in. to as thick as 1/32 in. after the mold wears down.

Novel features of plastic molds are ejection pins, ejection pin plate and steam ports. Ejection method must be carefully planned. For the mold insert of a compression mold an oil hardened tool steel is used. For intricate parts, an S.A.E. steel is preferred, while for general construction S.A.E. 3312 steel, carburized and heat treated will be satisfactory.

Pins used in plastic molds are as follows: (1) Ejection pins are used to push pieces

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National's skilled men, expert supervision, good materials, modern machinery, give you accurate cores which speed the production of precision castings.
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from cavities, and may be quite numerous; (2) Molders' identification symbol is made in an inconspicuous place; (3) Cavity number pin is used to identify cavities of multiple cavity molds.

Then there are (4) Insert holding pins for screw machine inserts or stampings usually molded integrally with plastic material; and (5) Guide pins, with which molds are accurately positioned in relation to one another. Injection molds are different from compression molds in that no loading space is needed for molding material.

Prime factors governing the choice of mold steel are: (1) Total production required, as this will determine the investment; (2) Ease of machining or hobbing; (3) Wear resistance; (4) Finish required on molded parts; and (5) Chemical properties of plastic in presence of steel.

The following steels apply to portions of mold making contact with plastic; S.A.E. 1010 or 3110, used for medium production, hobbed cavities and general molding; S.A.E. 3312, used for large molds, high molding pressures, and large production; and high carbon, high manganese, used for intricate, close tolerance molds, with minimum distortion. Hardening in all cases should be 62 to 64 Rockwell C.

—John Delmonte & William Renwick, *Iron Age*, Vol. 149, May 28, 1942, pp. 52-55.

Cast Iron for Aluminum Pistons

Condensed from "S.A.E. Journal"

The experiences of 7 different automobile manufacturers, in general, indicate that such problems as oil consumption, detonation, engine friction, piston scuffing, piston slap and rattle, etc., were not particularly serious when changing from aluminum to cast iron pistons.

The most serious problem was the increase in loads on the bearings and stresses in the connecting-rod and piston pins owing to the greater weight of the cast iron pistons. For the designs described, cast iron pistons weighed from 9-125% more than the equivalent aluminum pistons, the average being 65%. The percentage of piston weight necessary to permit balancing to a single weight indicates a possible variation of 5-10% in the uniformity of cast sections with present foundry practice.

Piston weight per cu. in. of cylinder-bore length varied from 0.43 to 0.61 oz./in.^{3} for aluminum and from 0.56 to 1.14 oz./in.^{3} for cast iron. Averages were 0.51 oz./in.^{3} for aluminum and 0.84 oz./in.^{3} for cast iron.

The conclusion is that the principal problem in using cast iron for pistons at this time is to design for low weight and adequate strength. In the final analysis, the design of the cast iron piston is controlled by the ability of the foundry to cast thin sections to close tolerances. As this part of foundry technique improves, cast iron pistons can be made lighter, and, possibly, as light as present designs of aluminum pistons.

—Wm. S. James, *S.A.E. Journal*, Vol.50, May 1942, Trans. pp. 177-187.

Tubing for Cylinder Liners

Condensed from "Aviation"

Cylinder liners for Rolls Royce engines manufactured by the Packard Motor Car Co. are tuned from seamless steel tubing having a heavy wall. This method of production is economical with the chromium-molybdenum steel (AMS 6380, equivalent to SAE 4140) employed, and avoids the forging operations by which cylinder barrels for many aircraft engines are made.

In this instance, of course, the cylinder barrel (it is not, strictly speaking, a "liner," though so termed) is for a liquid-cooled engine and thus does not require the cooling fins needed for air-cooled engines. For this reason, and because a much narrower flange is employed, a wall thickness, such as is produced in forgings, is not required.

Seamless tubing chosen for this liner is 6⅛ in. od. and has a ⅜-in. wall. It is supplied in lengths of 10 ft. 5 in., which can be cut with minimum waste into the lengths needed.

Outside diameters are plated with from 0.005 to 0.007 in. of nickel. This is applied as a protection against corrosion in contact with the liquid used for cooling the liner in service.

The nickel is rather soft to use as a locating surface where the liner is clamped in the cylinder block. Hence, the main bearing surface is subsequently ground down so as to leave only 0.003 in. of nickel and the surface thus ground is then given a coat of hard chromium by plating thereon to a thickness of 0.00075 in.

—*Aviation*, Vol. 41, July 1942, pp. 155, 157, 159.

Glass-Sealing Alloys

Condensed from "Transactions of the American Society for Metals"

A new series of iron-nickel-chromium alloys (plus other small additions) have been developed which have low expansion and other characteristics making them particularly suitable for vacuum-tight glass-to-metal seals. By varying the principal constituents of these alloys, coefficients of expansions ranging from 70 x 10^{-7} to 120 x 10^{-7} per deg. C. can be obtained.

Owing to the great inherent strength of the bond between these metals and their associated glasses, they should be well adapted for seals to glass where large mechanical stresses are encountered. These alloys are low in cost and can be made successfully by standard metallurgical methods. This series of alloys have excellent stainless properties.

Conventional Sealing Materials

In the early days of the incandescent lamp industry, platinum wire was used with lead glass to form a glass-to-metal seal. Owing to the extremely high cost of the metal, efforts were made to cut down the amount used by introducing a

COPPER ALLOY BULLETIN

REPORTING NEWS AND TECHNICAL DEVELOPMENTS OF COPPER AND COPPER-BASE ALLOYS

Prepared Each Month by the Bridgeport Brass Co. "Bridgeport" *Headquarters for BRASS, BRONZE and COPPER*

Duronze* III Speeds War Production By Reducing Serious Breakdowns

Use of Hard, Strong Silicon Aluminum Bronze for Gears, Valve Parts, Rollers Lessens Wear, Prolongs Service

The maintenance departments—or to be more precise, the factory machine shops—whose chief duty is to keep machinery operating twenty-four hours a day, 7 days a week, are doing yeoman service to speed America's war production. Machines must often be rebuilt and broken or worn parts repaired or replaced. It is true the vulnerable parts, whenever possible, are generally ordered from the machine builders. Replacements, however, are often made up by the machine shop and kept in reserve to reduce shutdowns to a minimum.

A Serious Problem

Building up a supply of stock parts has been a serious problem, as the scarcity of good experienced machinists and tool makers grows worse from day to day. What to do about it?

It doesn't take much to put a powerful hydraulic press, a swaging machine or some other industrial giant out of commission. A leaking valve seat, or a worn gear, roller, or bushing may mean a body blow to urgent production schedules.

Such vital parts wear out quickly even when they are made from the finest of steels and with the greatest of care. Although there has been no let down in quality today, constant twenty-four hour service is showing up weaknesses that would go unnoticed during normal times. Furthermore, many machines are operating beyond their rated capacities and certain parts now made from cast iron or cast bronze let go. Replacing such parts with a stronger material helps immeasurably to keep the machine in operation.

Duronze III Prolongs Life

Wear is the product of friction. Lubrication, by intercepting a thin film of oil to help take the load, reduces much but not all of the effects of friction. Friction is greater when the same kinds of material such as steel, for example, is rubbed against steel. Steel against a silicon aluminum bronze alloy such as Duronze III means less friction and less wear for both the steel and Duronze.

Remarkable increase in life has been obtained by using Duronze III against steel to reduce wear from either friction or pounding blows. In some cases, Duronze parts are reported to outlast as much as ten times the life of the original steel parts.

How Duronze III is Worked

Duronze III can be hot forged readily at a temperature slightly higher than that used for brass (about 1350° F.). Forging, of course, improves the metal as compared to a sand casting. Large gear blanks and other odd sections can be forged under a steam hammer from the cast billets which may be as large as 8″ in diameter. Duronze III can be machined from 50% to 70% as rapidly as free cutting brass rod. It is far from expensive. By installing vital parts made from Duronze III as original equipment, machine manufacturers can save themselves money in the cost of fabrication while, at the same time, increasing the service life of their product.

The use of Duronze III for wear resistance is not a new use for this unusual alloy. For a number of years it has been made into thrust screws for automobile truck construction where it meshes with steel. Threaded bushings for stainless steel valves is another important industrial application. Duronze III is also used for the manufacture of moving or sliding parts in machine guns. It often replaces comparatively weak sand cast bronze gears.

> *KEEPING HEAVY DUTY MACHINERY OPERATING*
> *24 hours per day—7 days per week.*
>
> More friction occurs when steel rubs against steel than when steel rubs against Duronze III. Remarkable increase in the life of slow moving, or sliding parts of machines has been obtained by using Duronze III to:
>
> REDUCE WEAR FROM FRICTION
> All types of gears, pinions, thrust screws operating against steel. Carriage rollers running on hardened steel tracks (reversing direction causes rollers to spin on track and wears both rollers and track.)
>
> INCREASE STRENGTH
> Valve seats, stems, parts of valves controlling powerful hydraulic equipment; oil rings, pump bushings. Replacing cast bronze or cast iron with hot forged Duronze III parts, increasing capacity and service life.
>
> WITHSTAND HEAVY IMPACTS
> Rollers for rod and tube swaging machines.
>
> WITHSTAND CORROSION
> Parts for acid pickling machines that become wet from acids.
>
> SUGGESTED USES
> War equipment that must stand up and remain precise with minimum maintenance on the field of battle far from repair bases and sources of replacement . . . tanks, jeeps, machine guns, gun mounts, instruments.

*PAT. NO. 1,810,242

Best For Slow-Moving Parts

Duronze III, however, is not recommended as a bushing for shafting that revolves at high speeds. It is not a "bearing" alloy, such as a highly leaded bronze. It is a

(Continued on Page 2, Column 2)

The life of heavy duty equipment can be increased through the use of Duronze III to replace such iron, steel and bronze parts as valve stems, seats and parts of high pressure hydraulic pumps, gears for elevating equipment, rollers and parts for swaging machines, roll stands, and metal extrusion equipment. Duronze III offers advantages for parts anywhere that come in contact with steel except where high speed is involved.

COPPER ALLOY BULLETIN

ALLOYS OF COPPER

This is the thirty-sixth of a series of articles on the properties and uses of the copper alloys.

COPPER-SILICON ALLOYS

The alloy containing 97% copper and 3% silicon known as Duronze II, described in the July issue of the Copper Alloy Bulletin, deserves further consideration. Because it has been used commercially only a comparatively few years, it is not as well known as it should be.

Duronze II is an alloy which, although it is composed of 97% copper, is approximately twice as strong and tough as copper itself. Yet it retains many of the characteristics of copper, namely good workability either hot or cold; as good if not better resistance to corrosion and season or corrosion cracking. In many ways it resembles mild steel in physical strength and copper in corrosion resistance.

The annealing characteristics of Duronze II sheet are shown in Fig. 1. Material rolled about 4 B & S numbers hard, having a tensile strength of about 95,000 lbs. per square inch, begins to soften soon after it attains an annealing temperature beyond 300° C. At 650° C, its tensile strength is slightly under 60,000 lbs. per square inch—a value which places it among high strength alloys.

The cold rolling characteristics of Duronze II are given in Fig. 2. Beginning with annealed material having a tensile strength of 60,000 lbs. per square inch, a 40% reduction by rolling brings the tensile strength of this alloy to 100,000 lbs. per square inch with an elongation of about 5% in two inches.

Duronze II conforms to ASTM specifications B96-41T Type A for hot rolled plates, and sheets for pressure vessels; B97-41 Type A for sheets for general purpose rod; B99-41 Type A for wire; and U. S. Navy specifications 46-B27 and Federal specifications QQC 591 Class A for rod, sheet and strips.

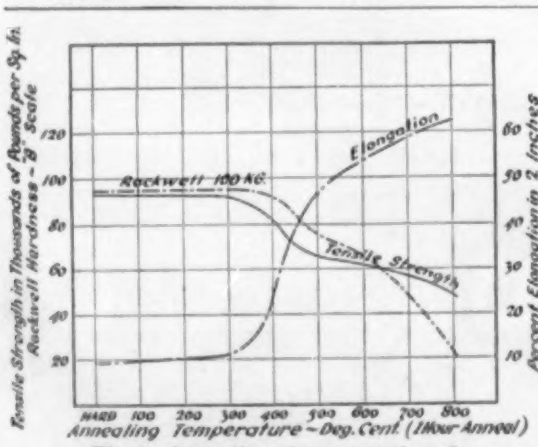

Fig. 1. Annealing characteristics of Duronze II Sheet (.050 inch thick)

Memos on Brass—No. 31

To produce sound, strong joints when soldering brass, it is important that the parts be free from oxide or scale and that a proper flux be used. It may be necessary to resort to alkali cleaning, pickling, acid dipping, filing, sandpapering, scraping, or scratch brushing to assure a clean surface. The flux, which is applied just before or at the same time the heat is applied, may consist of vaseline, tallow, palm oil, or resin. Where a more active flux is required, zinc chloride will be found satisfactory. To reduce the melting point of the flux, ammonium chloride may be added.

Duronze III Speeds War Production

(Continued from Page 1, Column 3)

hard, strong alloy that can be used to advantage for slow moving parts which have to be tough and strong to resist wear. It also has good corrosion resisting properties and can be used for parts which are wet by acids.

A few of the applications for Duronze III replacements in heavy machinery include the following: carriage rollers for a tube reducing machine; large valve seats and valve parts for hydraulic tube extrusion and rod extrusion machines; parts for rod swaging machines; oil rings; pump bushings; and parts for acid pickling machines.

Technical properties and engineering data are described in the Duronze III Technical Bulletin which will be supplied upon request.

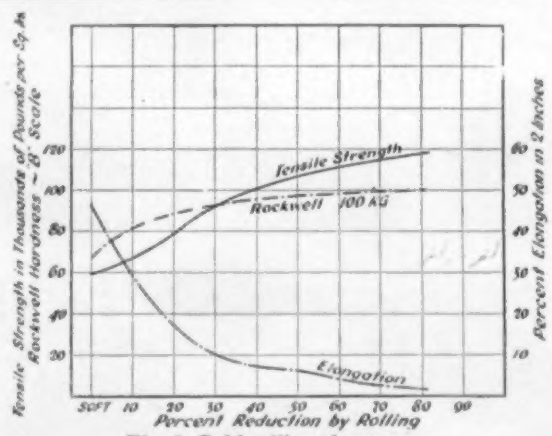

Fig. 2. Cold rolling characteristics of Duronze II Strip.

NEW DEVELOPMENTS

An adjustable hand tool holder has been developed to hold square or octagon shaped tools. It adjusts to hold any size piece from $\frac{1}{4}$" to $\frac{3}{4}$" and other $\frac{1}{2}$" ranges up to $1\frac{1}{4}$" square. The holder can be furnished with a leveler on the front end which allows the operator to make several impressions in a straight line. **(No. 350)**

A cleaning liquid is announced which is said to remove mineral oils from metal surfaces or from the hands. The product is claimed to be non-toxic and non-inflammable. It is said to leave a thin rust-preventive film on a metal surface and to be particularly suited for application in place of inflammable materials. **(No. 351)**

A retrieving tool is offered for securing small parts that have been dropped into inaccessible places. It is described as a plier-type, trigger-operated tool. The jaws also carry cutting edges which can be applied to cut wire. The lever ratio between the jaws and the trigger is said to be 15 to 1. **(No. 352)**

A clamp of hinged design has been developed which is said to hold on either straight or tapered surfaces. The operator applies it to the work, pushes down on a ratchet rod that replaces the long screw in standard construction, then applies final tightening pressure by a short screw at the side. Average time for the operation is said to be four seconds. **(No. 353)**

A protractor is offered which, it is claimed, can be employed on pipe from 3" to 18" in diameter to lay out a desired angle for cutting. It is also said to be suitable for similar application on a structural member or flat surface. A plump-bob level indicator is assembled vertically on the base with its axis at right angles to the center line through the length of the base. On one side is a dial carrying divisions to 90 degrees on each side and assembled to swivel over this dial is the hinged support for the protractor arm. **(No. 354)**

An adjustable wrench has been developed in four sizes, 8", 10", 12" and 14" in both nut and pipe wrench styles. Extreme jaw opening widths run from $\frac{4}{5}$" to $1\frac{3}{4}$" for the range. To tighten a nut the handle band is zipped and the jaws automatically adjust themselves in a vise-like grip on the nut. To loosen, the handle band is zipped downward. **(No. 355)**

A straightening press is offered for handling a variety of parts which is said to be ideal for a heat treating shop or tool room. It features a 12" opening, 5" throat, and 9" stroke. Its table is 8" wide and it extends $5\frac{1}{2}$" in front of the centerline of the screw. **(No. 356)**

A belt-repairing substance is offered which is described as a putty-like material containing a very small proportion of crude rubber. An average repair made with this product on a conveyor belt or rubber clothing is claimed to contain less than one forty-eighth of an ounce of rubber. **(No. 357)**

This column lists items manufactured or developed by many different sources. Further information on any of them may be obtained by writing Bridgeport Brass Company, which will gladly refer readers to the manufacturer or other source.

three-piece lead-in, in which a short length of platinum 4 to 6 mm. long, was welded at each end to a copper or nickel lead wire.

The platinum to lead glass seal was not a particularly good match, but with proper annealing of the seal gave satisfactory results. In any case the use of this material is only of historical value, due to its high cost.

Since about 1913, when Eldred invented the "dumet" lead wire, this material has been used quite generally for sealing with lead glass in both the incandescent lamp and radio tube industry. These seals have been satisfactory when used with comparatively small diameters of wire (under 0.040 in.). However, in so far as expansion characteristics are concerned, the dumet does not match very closely the glass with which it is used and radial compression strains remain in the seal.

Dumet is a bimetal having a core of 42% Ni, bal. Fe alloy, around which a copper sleeve is drawn. This composite slug is first swaged and then drawn down to the desired wire size. The volume of copper is held at approximately 25 per cent of the total.

Since "dumet" is comparatively expensive, it is usually used in a 3-piece weld, in which a short section of dumet, from 4 to 6 mm. long is electrically welded to copper or nickel leads. The dumet section is sealed into the glass while the two leads extend outwards from each side of the seal.

Since the expansion of the core is substantially less than the glass with which it is used, a seal having radial compression results. The outer copper sheath tends to flow somewhat and thus relieves a large percentage of the strains caused by the mismatch of the alloy core and the glass. With dumet leads above 0.025 in. in diameter, the seals are badly strained and since the adherence of the oxide to the copper sheath is weak, seals are not considered safe.

The New Problem

During the past few years the Hygrade Sylvania Corporation had developed the "lock-in" radio tube. In this tube it is necessary to use metal pins, which form contact with the socket; then also form an integral part of the tube itself, and as such, must be capable of making a vacuum-tight seal with the lead glass used in the tube stem.

Also these pins must be made from a material having low electrical resistance and one having sufficient mechanical strength to withstand bending due to normal tube handling. Since obviously dumet was undesirable due to the large size pin needed to insure mechanical rigidity (0.050 in. diam. or greater), and due to the high comparative cost of dumet, and for other reasons, other available alloys were investigated.

A large number of radio tubes were made up using as pin material an alloy containing 27-30 per cent Cr, balance iron. With suitable annealing this alloy and the special No. 3 glass made fairly strain-free seals which were satisfactory in so far as glass-to-metal seals were concerned.

However, when the No. 3 glass cup was sealed to the No. 4 lime glass bulb (Corning G-8) considerable strain was set up due to the differences in expansivity of the glass. This was also true in the case of sealing the (Corning G-12) No. 2 glass exhaust tube into the bottom of the cup. These mismatches in glasses resulted in an appreciable loss of radio tubes, since cracks developed due to these strained conditions.

Since there were no commercial alloys available that would seal satisfactorily with No. 1 glass for our particular purpose, it was decided to make an investigation of low expansion alloys and, if necessary, to develop alloys which would form a satisfactory seal with Nos. 1 or 2 glass.

In my study of glass-to-metal seals several factors must be considered:

(1) The expansivity of the glass and metal must match closely over a given temperature range.

(2) It should be possible to obtain a layer of oxide on the surface of the metal which will adhere tightly throughout all processing involved in the forming of the glass-to-metal seal.

(3) This oxide coating must be of such a nature and must be thick enough, so that it prevents the formation of iron oxide, or other loosely adhering oxides on the surface of the metal during subsequent processing.

(4) This oxide coating should dissolve (wet) mutually with the glass.

(5) It is desirable that the oxide formed on the metal be of a sufficiently low electrical resistance so that it may be welded easily to other metals such as nickel and iron by electric spot welding.

(6) It is essential that the alloy for the glass-to-metal seals be a reversible one, in so far as elongation is concerned and that no thermal critical points occur in any temperature region that the finished article might be subjected to.

(7) The alloys should be comparatively low in cost and should have compositions which are relatively easy to melt and must be capable of close reproduction in commercial quantities. (10,000-50,000-pound melts)

(8) These alloys must be of such nature that their physical characteristics will allow normal hot and cold working of the material, without forming cracks, seams or other mechanical defects. Also it is desirable to have an alloy that is capable of being processed so that different degrees of hardness or ductility may be obtained.

The New Alloys

Generally speaking, additions of the following elements tend to raise the expansions of known low expansion alloys: Aluminum, copper, iron, nickel, chromium, silicon, manganese, beryllium, and columbium. An exception to these is the iron-chromium system.

It was found that "Alloy No. 4" (42 per cent Ni, 6 Cr, balance iron) contained enough chromium so that a satisfactory protective layer of Cr_2O_3 was formed by proper processing. However, this oxide did not satisfy condition No. 2, above.

After considerable investigation of various oxide conditions it was found necessary to add to No. 4 alloy or any similar alloy a fractional amount of a constituent which would tend to make the oxide adhere tightly to the surface of the alloy. This addition was of extreme importance in alloys for this use. Various constituents were tested among those

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boron, aluminum, thorium, beryllium, zirconium, strontium, carbon, titanium and others.

It is important to note that, generally speaking, additions of compound-forming elements tended to increase the adherence of the basic chromium oxide to the surface of the metal. After a study of these special additions one was selected which gave optimum results, and had the least effect on thermal expansion.

The "No 4" alloy, while entirely satisfactory for our specific use, after thorough annealing tended to become somewhat ductile. As a result of the addition of approximately 0.5 per cent carbon to the basic No. 4 alloy, the material will retain its hardness to a large extent even after thorough annealing.

—W. E. Kingston, *Trans. Am. Soc. Metals,* Vol. 30, Mar. 1942, pp. 47-67.

Steels for High Temperature Steam

Condensed from "Trans. Am. Soc. Mech. Engrs."

The steam temperatures used in modern central stations are now closely approaching those at which hydrogen is produced commercially and the reaction between steam and steel, according to $4\ H_2O + 3\ Fe = Fe_3O_4 + 4\ H_2$, takes place. It was therefore investigated how the steels available for high temperature service behave against the corrosive attack by hydrogen under these conditions, by measuring the amount of corrosion on unstressed specimens up to 1400 deg. F. and pressures up to 1600 lbs. per sq. in. gage also taking into account the effect of surface finish and temperature fluctuations.

The general conclusions are: (1) The resistance of alloy steels to high-temperature steam is greatly influenced by the amount of chromium present. Alloy steels containing 7% or more of chromium are very resistant to corrosion produced by steam at temperatures up to at least 1400 deg. F. The 18-8 stainless steels showed practically no corrosion when subjected to steam up to 1400 deg. F.

(2) The corrosion rate is very rapid during the first 500 hrs. of testing and then gradually diminishes as the time of exposure to steam continues. (3) Steam temperatures greatly influence the corrosion of steels. Except for steels containing 7% or more chromium, the corrosion rate increases very rapidly at temperatures in excess of 1100 deg. F.

(4) The steels tested can be grouped into 3 general classes according to the type of scale formed. The first group contains low carbon, carbon-molybdenum and low chromium steels which are covered with a thick, porous, tightly adhering scale.

The second group of the 4-6% Cr and 2 Cr-Mo-Al-Si steels, forms a very brittle scale which easily flakes off under fluctuating temperatures. The third group consists of steels having a chromium content of 7% or more on which a very thin, non-porous, tightly adhering scale is formed.

(5) Scale formed on the inner surface of a tube does not flake off as readily as the scale formed on the outer surface of a tube.

—H. L. Solberg, G. A. Hawkins & A. A. Potter, *Trans. Am. Soc. Mech. Engrs.,* Vol. 64, May 1942, pp. 303-316.

Applications of Zirconium

Condensed from "Revista Brasileira"

The Brazilian zirconium-containing deposits can be grouped into 4 types: (1) Zirconium type; adelpholite with 47.42%, anderbergite with 41.2%, and auerbachite with 55.18% ZrO_2; (2) acid type; catpleiite with 30-40%, lovenite with 30% ZrO_2 and some ores of only scientific value; (3) oxidic type; baddeleiite 99%, brazilite 80%, zirguelite 50% ZrO_2; (4) tantalate type; of little commercial value.

The principal deposits are in Minas Geraes (Sao Paulo). In the steel industry, ferrozirconium with 40-90% Zr is used. This product is obtained by alumino-thermic processes; it usually contains a small percentage of titanium.

A filament for electric bulbs is made at present which has the composition 65 Zr, 26 Fe, 0.12 Ti and 7.7% Al. This alloy is obtained by reduction with finely powdered aluminum together with iron oxide, titanium or any other desirable metal.

Wide use of zirconium is made in refractories which possess a fusion point of about 4510 deg. F., low thermal conductivity, low porosity and are therefore slightly permeable to liquid metals and well able to withstand thermal shocks. They do not resist hydrofluoric acid, fluorides or molten bisulphates.

Metallic Zr is produced principally from finely powdered fluorides in the presence of metallic potassium according to the reaction $2\ KF.ZrF_4 + K_4 = 6\ KF + Zr$ or by the reduction of the oxide with metallic calcium according to $ZrO_2 + Ca_2 = Zr + 2\ CaO$. For this reaction a commercial calcium of 95% purity can be employed. A zirconium of 97.7% purity is obtained; the remainder consists of ZrO_2.

—A. Furia, *Rev. brasil.,* Vol. 13, Feb. 1942, pp. 99-103.

Beryllium Copper Springs

Condensed from "Aero Digest"

The growing shortage of tin, the hardening element in phosphor bronze, is emphasizing the place of beryllium copper as a spring material in aircraft construction, instruments and accessories. Beryllium copper has higher tensile strength, endurance and electrical conductivity than any one of the ordinary corrosion-resistant spring alloys.

Because higher safe working stresses can

be used, beryllium copper can be designed to do the same work of other corrosion resisting spring materials with less weight. Its electrical conductivity is twice that of phosphor bronze. In addition, the higher heat resistance of beryllium copper permits its use at temperatures 100 deg. F. higher than bronze will stand.

Properties

Beryllium copper consists of approximately 2 per cent Be and 98 Cu. Other elements are added, up to about 0.5 per cent by some alloy manufacturers, but the basic advantages are due to the effect of beryllium. The outstanding property of this copper alloy is that, like carbon steel, it can be formed in the soft condition, and then hardened for spring properties by heat-treatment.

In processing spring material, beryllium copper is made susceptible to hardening by a solution heat-treatment at about 1425 deg. F., followed by a rapid quench. In the annealed condition, the material closely resembles annealed phosphor bronze. (The solution heat-treatment is usually performed by the alloy manufacturer). Generally, the material is given additional cold work or reduction to introduce some spring temper, since physical properties are thereby improved. Because of its unusual properties, attempts to use conventional spring-making processes on beryllium copper have usually resulted in unsatisfactory springs. Ordinary spring coiling and forming machines were originally designed and developed to make springs that were used just as they came off the machine. But the heat-treating operation necessary to obtain the desirable properties of beryllium copper introduces distortion and changes in modulus.

In addition, the final heat-treatment is sensitive to the amount of cold work introduced by coiling or forming, as well as the temper of the material as purchased. Uniformity of hardness, modulus, conductivity and stability (freedom from drift) requires the heat-treatment for each production run to be predetermined. No standardized heat-treatment can be expected to result in uniform final spring properties.

Entirely successful results are being obtained by "micro-processing," a combination of special forming and coiling machines and a heat-treatment, determined by tests on a pilot lot. Equipment specially designed for beryllium copper is regularly turning out springs in production quantities to close tolerances, two to ten times the accuracy previously possible.

Controlled heat-treatment also makes possible an exceptional degree of stability or freedom from drift, because beryllium copper is the only spring material that can be completely stress-relieved at the hardening temperature without loss of strength.

In several instances where comparative tests have been made, beryllium copper springs have undergone drift changes of no more than 1/100 the amount experienced with steel or bronze over a given service period. Drift performance in comparison with stainless steel is even more outstanding.

Applications

In one coil spring application (in a centrifugal tachometer) close tolerances on a free length and deflection rate and the minimum drift of the beryllium copper spring made possible a saving in calibrating expense several times the cost of the spring. Free length, for example, is held to ± 0.005 in., and deflection rate to closer than 1 per cent in large quantities.

Another aircraft control device uses a beryllium copper bearing centralizer spring, held to a tolerance of ± 0.002 in. for the length under load; even with these tolerances, this spring is obtainable in production quantities of several thousand per day.

A stainless steel brush spring in another control device was giving unsatisfactory service due to drift resulting in a drop in brush pressure with time. Beryllium copper springs solved the drift problem, and a tolerance of ± .003 in. in outside diameter gave a better fit on the brush shank as well as a more uniform clearance in the brush spring guide. Many other applications already have been made in radio and communication equipment. Electrical contact springs, crystal clips, jack springs, socket springs and relay contact blades are typical of important uses being made of beryllium copper.

—Robert W. Carson, *Aero Digest*, Vol. 41, July 1942, pp. 150, 153, 272-273.

Testing and Control

4

METHODS, EQUIPMENT

Physical and Mechanical Property Testing and Inspection • Routine Control and Instrumentation • X-ray and Magnetic Inspection • Spectrographic and Photoelastic Analysis • Corrosion- and Wear-Testing • Examination of Coatings, Surface Measurements • Metallographic Structure and Constitution

CONTENTS

New Electron Microscope

Condensed from an American Society for Testing Materials Paper

Images of objects may be formed in two basically different manners. Either the picture as a whole may be projected simultaneously on the recording surface, as typified by the photographic camera, or it may be formed by the sequential recording of its elements, as a painting takes shape under the successive brush strokes of the artist. Practically all optical instruments, including the *conventional* electron microscope, utilizes the first method for image reproduction.

Television and electric picture transmission or facsimile, on the other hand, analyze the picture to be transmitted into a large number of minute picture elements, successive signals derived from adjacent elements and proportional to their brightness serving to control the intensity distribution in the resynthesized image on the viewing tube screen or recording paper. The *scanning* electron microscope belongs to the same class of image forming devices.

The special sphere of usefulness of the scanning electron microscope lies in the observation of surfaces of "opaque" objects, just as the standard electron microscope is primarily adapted for the viewing of "transparent" specimens. The boundary between transparency and opacity for electrons of the order of velocity normally employed in electron microscopes lies in the neighborhood of 1/100,000 of an inch.

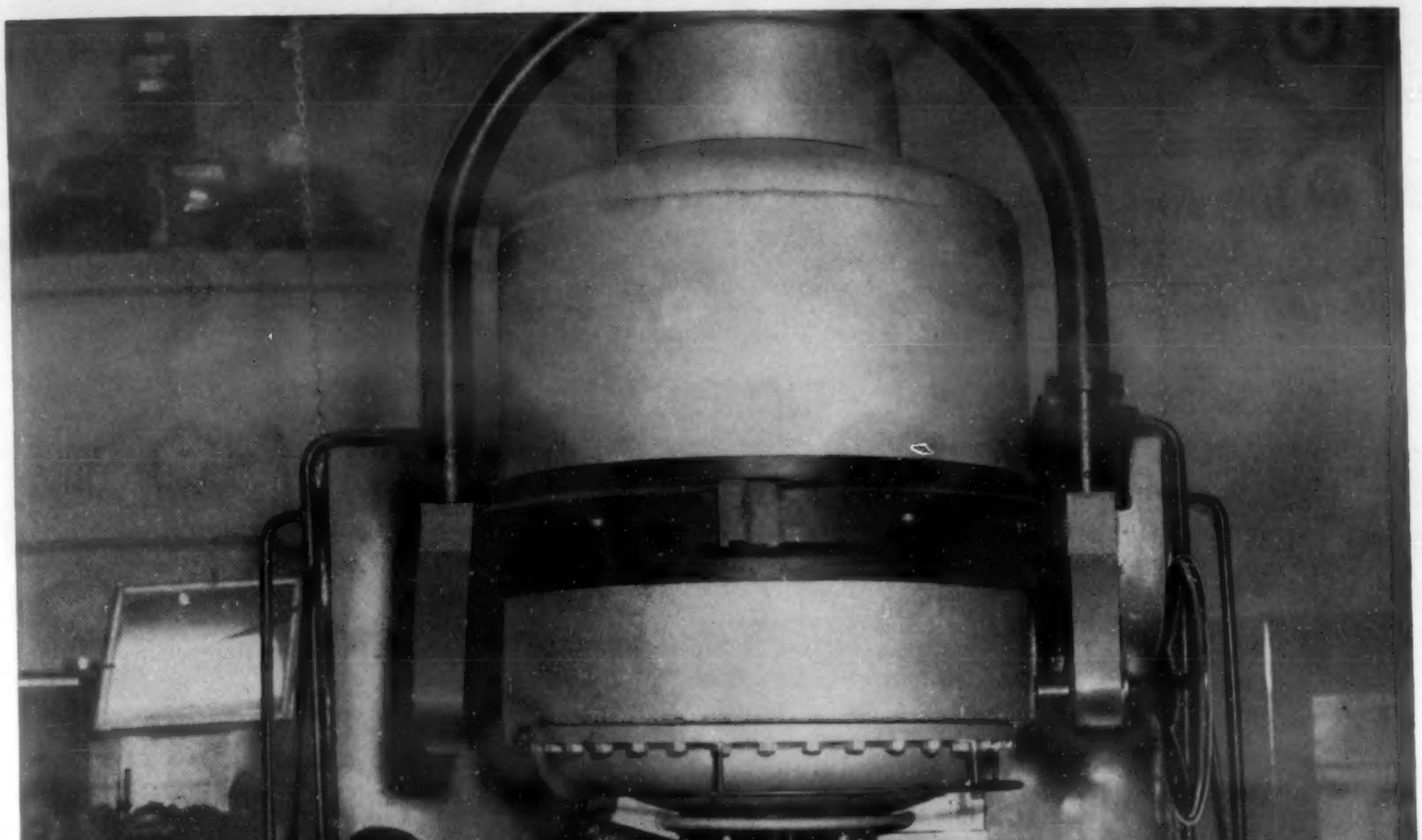
The standard electron microscope cannot be adapted to the direct observation of surfaces without a great loss in resolving power. It is thus the aim of the new (scanning) electron microscope to extend the range of observation in metallographic microscopy just as the standard electron microscope has already extended it in the bacteriological, chemical and related fields.

Various researches concerned with the application of the methods of electronic television to problems of microscopy have been carried on in the RCA Laboratories over a period of 8 yrs. Thus, at an early stage a directly coupled television pick-up and receiver unit was combined with an ultraviolet microscope so as to yield a visible image of readily controlled brightness and magnification. Here the television equipment served primarily to convert an invisible into a visible image and did not participate in the formation of the original magnified image.

In order to obtain a genuine scanning microscope it was necessary to replace the ultraviolet-sensitive mosaic in the pick-up tube by the object itself. If, with the latter arrangement, the scanning amplitude in the pickup tube—that is, the scanning area on the object—is reduced, leaving the scanning in the viewing tube unaltered, an enlarged image of the object is formed on the fluorescent screen.

The variation of brightness in the latter corresponds to the variation in the secondary emission sensitivity of the specimen. The magnification of the image is simply equal to the ratio of the scanning

SPEEDS INSPECTION...



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amplitudes on the object and on the screen of the viewing tube.

Although scanning microscopes of relatively low resolution (down to 0.00005 in. or 1 micron) were successfully constructed even with the image observed directly on the fluorescent screen of a kinescope, high-resolution instruments required a slower method of recording. A facsimile receiver, registering an image in 8 min., (as compared with 1/30 of a second for a television receiver) proved to be a satisfactory solution. The electron source is at the bottom of the microscope and consists of a thin tungsten wire fed by a regulated radio-frequency power supply. It may be oriented with respect to a two-element electrostatic lens comprising the grid and the anode of the electron gun by means of 3 micrometer screws. A 3000-cycle square voltage wave is applied to the grid so as to give the beam, and hence the signal current, a 3000-cycle modulation. In addition to this, a variable d-c. grid bias is provided to regulate the current in the beam.

On striking the specimen, the primary electrons eject from the latter secondary electrons. These have low initial velocities, corresponding to accelerating voltages between 0 and 10 v. The strong accelerating fields between the specimen and the uppermost electrode of the final lens draws them back through the final lens, which focuses them at some point between it and the inclined fluorescent screen.

In the earlier instruments the scanning was accomplished by mechanical displacement of the specimen, the motion of the latter being linked electrically or hydraulically with the displacement of the recorder drums with the aid of suitable cams mounted on the axes of the drums. Since adequate precision in the scanning could not be obtained by this means, magnetic scanning was provided in the final instrument.

The area of the specimen which is scanned is normally only about a thousandth of an inch in diameter. The resolution obtained with the present instrument is of the order of 500 Angstrom units, representing a considerable improvement over the optimum obtainable with the light-optical metallographic microscope. As with any new device, it is not possible to judge the full range of utility of the scanning microscope at the present time.

—V. K. Zworykin, J. Hillier & R. L. Snyder, Paper, *American Society for Testing Materials,* June, 1942 meeting.

Inspecting Aircraft Castings

Condensed from "The Foundry"

Soundness and continuity of metal are checked by X-ray or radium gamma ray by the Bendix Corporation in inspecting sand castings. For highly stressed parts a sound casting is imperative since failure may occur from internal flaws.

Using the X-ray, a shadow-graph of sections is recorded on a film. Internal flaws are shown as light or dark areas. If a defect is less dense or lower in atomic weight than the metal, it will be shown

A New Star over America

THIS is the new All-Navy "E" burgee. With its added star, it signifies that, for a period of over six months, production of Navy material has been apace of schedule. First flown in America over the Bausch & Lomb plant, it is official Navy recognition to B&L workers of their continued achievement in Production for Victory. It replaces the Bureau of Ordnance flag and "E" pennant awarded Bausch & Lomb July 25, 1941.

The Navy "E" has always been an honor to be striven for, to be guarded jealously. On gun turret, battleship funnel, or the flagstaff of an industrial plant, it is a symbol of championship performance. But today, Navy officials—and the American public—are anxious to see this award in as many places as possible. Because "championship performance" is what America needs today—all down the line.

Workmen at Bausch & Lomb are devoting to the specific implements of war, the experience and skills gained in the production of scientific optical instruments. Today the world depends on America's men-behind-the-men-behind-the-guns to destroy the forces of aggression—that the ideals of individual freedom may survive.

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as a dark area. If it is more dense it will be shown as light area. Defects such as blow holes, tears, shrinks, cracks, inclusions, etc. can easily be recognized with the X-ray.

By checking results of each charge with the X-ray, the best method for producing sound castings can be determined. The size of chills used and their relative position to gates and risers are important in determining the amount of pinhole porosity. Changing the risers, gates and chilling will eliminate it. Hardness is checked quickly on modern hardness testing machines set at 1000 kg. load.

Before the castings can be molded on a production basis, it is essential to know whether the parts will have sufficient extra material for machining; whether the wall thicknesses, radii and fillets are as specified. Bosses and pads should be correctly placed.

During inspection the casting is painted with blue layout ink to make scribed lines visible. It is clamped to an angle plate. Working center lines are squared to the face of the surface which will not be machined.

The casting is then adjusted until this surface is parallel with the surface plate. The block is turned 90 deg. so that the part which was perpendicular is parallel to the plane surface. With the surface gage true, the centers are determined.

The dimensions of the blueprint are taken and transferred to the casting. By the use of dividers, drilled holes, bores, etc. are marked on the casting.

A dimensional tolerance varying from 1/32 in. on unfinished surfaces of medium castings to slightly less on small parts and on somewhat larger castings, is allowed. This requires sound knowledge of foundry practice.

In inspection, calipers are used to check uneven wall thickness. On very thin sections calipers with dial indicators, graduated in thousandths, are used.

—Walter Rodgers, *Foundry*, Vol. 70, May 1942, pp. 104, 192-193.

Flaws in Non-Magnetic Metals

Condensed from "Journal of Applied Physics"

Flaw detectors for nonmagnetic materials are described that are based on the measurement of eddy current fields set up by alternating magnetic fields introduced into the test object. Their applications are discussed.

Eddy currents in the test objects are generated by solenoids supplied by vacuum tube oscillators operating at 500 or 1000 cycles per second, and the signal voltages are picked up directly by auxiliary coils on the magnetizing unit. Both changes in intensity and phase of the signal voltage are measured.

Shapes of testers are described which are suitable for testing plates, bars and welded seams. Fatigue cracks and flaws whose plane is normal to the surface, surface irregularities and even blow holes and inclusions near the surface can be detected.

—I. Vigness, J. E. Dinger & R. Gunn, *J. Applied Physics*, Vol. 13, June 1942, pp. 377-383.

X-Ray Diffraction Tube

Condensed from "Journal of Applied Physics"

An X-ray diffraction tube is described in which several new features in diffraction tube design are incorporated.

These are: (a) Thin beryllium windows sealed close to the target into a grounded metal housing about the anode, (b) a cathode structure which is claimed to eliminate most of the contamination of the anode by tungsten, and (c) complete shockproof design permitting use of the tube at points remote from its transformer. Due to the low absorption of the 0.010 in. beryllium windows and the small distance between these and the target much more intense X-radiation may be obtained.

The beryllium used is vacuum melted and alloyed with 0.2% Ti to remove the oxide causing lack of hot malleability. The windows are brazed in several operations with alloys such as 50-50 silver-copper to the tube body by a special technique to be reported on later.

—R. R. Machlett, *J. Applied Physics*, Vol. 13, June 1942, pp. 398-401.

books

FOR METALLURGICAL ENGINEERS

Copper Metallurgy

METALLURGY OF COPPER. *By Joseph Newton & Curtis L. Wilson. Published by John Wiley & Sons, Inc., New York, 1942. Cloth, 6¼ x 9¼ in., 518 pages. Price $6.00.*

Perhaps the most difficult decision for those who undertake to write books on metallurgy today is to determine what sort of an audience they are writing for. There have been tremendous advances in theoretical metallurgy since, say, Peter's classic volumes on the metallurgy of copper, but it is doubtful whether there have been equally sweeping changes in plant practice.

The operator has to keep his plant going and try to make some money; and while he has great respect for theory, he is not altogether unlike the farmer in the old story who replied when a county agent of the Department of Agriculture informed him that he had come to teach him how to farm better: "Hell, I don't farm half as well as I know how to already."

Should one write for the operator, who is chiefly interested in the latest improvements of plant practice; for the student who needs a solid foundation of basic theory, as it is currently understood; or try to write a monograph on the subject?

Any one of these things can be done, but a true monograph usually runs to a great many pages, and needs the sponsorship of a learned society or foundation to finance its publication. To stick to the monograph form, as the authors of this volume seem to have done, and still keep down the number of pages leads to difficulties.

Probably this is the reason why, under the discussion of leaching processes no mention is made of the Calumet and Hecla process, though the Kennecott plant is described at some length. It is all the more odd, on looking up the citation of C. H. Benedict in the index, to find that it refers to a paper he wrote on steam stamps in 1938, and not to his pioneer work on ammonia leaching of the Calumet and Hecla mill tailing.

Similarly, the treatment of metallurgical processes from the standpoint of modern thermodynamics is brief in the extreme, and one wonders why the authors thought it desirable to curtail it, while at the same time finding space for Chapter XII on the production of copper—data which are available in yearbooks that are brought up to date yearly. The same may be said of numerous tables of data reprinted from Eshbach's "Handbook of Engineering Fundamentals."

The reviewer would have liked to see the space used for such things devoted to a fuller discussion of the rationale of operating practice. Thus on pages 165-170 converter linings are discussed without making clear why basic linings could not be maintained before the advent of the Pierce-Smith and Great Falls types of converter, nor why they are now feasible. Nor is there any critical comparison of these two converter types, with the reasons why some plants prefer one and some the other. Various other instances might be cited, and the same point made regarding basic theories.

All this, however, is rather like looking a gift horse in the mouth, and it would be more logical to be grateful that the authors have presented a readable text based on present-day operating practice.

—T. T. READ

Heating Furnaces

INDUSTRIAL FURNACES—VOLUME II. 2ND. EDITION. *By W. Trinks. Published by John Wiley & Sons, Inc., New York, 1942. Cloth, 6¼ x 9¼ in., 351 pages. Price $5.00.*

As stated in the preface to this edition, the plan and scope of the volume is the same as for the first edition, where the author states that the book is intended for plant engineers, furnace sales engineers, furnace erectors, and furnace operators. It is significant that metallurgical engineers are omitted, since they have become largely responsible for furnace performance in recent years. The only criticism of the book might be that many of the things that metallurgists would like to know more about are not considered. However, the entire contents of the book should be of vital interest to all those who are interested in the selection and operation of their principal tool.

The chapters in this book on all forms of fuels and combustion devices are excellent, containing information on developments since the publication of the first edition, and the charts and tables on fuels and burner capacities are of especial value. The chapter on temperature control is brief, but long enough to give clearly the principles which underlie and differentiate the several confusing types of temperature control.

The section on control of furnace atmosphere clearly explains the mechanism of this control in detail, and is valuable from that standpoint, but does not cover the subject of how this control is operated to minimize decarburization and other troublesome metallurgical effects of heat.

Labor saving devices in the handling of materials through furnaces are carefully explained and described in one chapter, and the final chapter is a general discussion of furnace comparisons, principally as applied to heavy metallurgical furnaces and including cost data and other information necessary for intelligent selection of furnaces to suit various specific needs.

In conclusion, the book is a valuable contribution to the mechanical engineering of the industrial heating furnaces, which is its purpose, and it is a worthy companion volume to the other reference works by this well known engineer and author.

—M. H. MAWHINNEY

An Early Iron Worker

Iron Pioneer—Henry W. Oliver. *By Henry Oliver Evans. Published by E. P. Dutton & Co., Inc., New York, 1942. Cloth, 6 x 9 in., 370 pages. Price $3.50.*

As the preface says, "Each era had its symbols. For the first, the rifle and the horse; for the second, the plow and wagon; for the third, the blast furnace and railroad; for the fourth, the assembly line and experimental laboratory." This book deals with the third, tracing through Oliver, the development of the steel industry and particularly of Pittsburgh.

Oliver's part in development of blast furnaces, of rail and water transportation, of Lake Superior iron ore deposits, and in financing Pittsburgh steel industries, is the main theme, but the background is a general picture of the times.

The book is crammed with historical facts, of interest to those of metallurgical bent, but somewhat obscuring the woods by the trees for the general reader, to whom, for easy reading and sustained interest, it may appear inferior to many other modern biographies.

The metallurgist who cares to know another side of the history of the steel industry besides the purely technical one, will find it well worthwhile.

—H. W. GILLETT

(Continued on page 363)

Steel Maker's Autobiography

KNOTTED STRING—AUTOBIOGRAPHY OF A STEEL MAKER. *By Harry Brearley. Published by Longmans, Green & Co., New York, 1942. Cloth, 5¾ x 8¾ in., 198 pages. Price $2.50.*

If you like autobiographies, you will like this, whether you have any interest in steel or not. Lots of people who dislike autobiographies but like philosophical essays will like this, for it is primarily such an essay. And for those interested in steel, or in research, the side comments on these topics are delightful.

Brearley was born in dire poverty, left school to go to work at eleven, and was entirely self-educated, by reading and thinking. How effectively he educated himself, the book demonstrates, for it is decidedly good writing.

Brearley's father was a steel-melter. The boy's first steady job was washing beakers in the analytical laboratory. From this he progressed to analyst, metallurgist, research man and consultant. The step from analyst to metallurgist was made during a 4-year stay in Riga during the establishment of a steel works there. The account of the development of temperature control in heat treating, and of evaluation of the product by fractures is extremely interesting. He was very much on his own.

Referring to the superstitions about "body" in steel he remarks that nothing could be imported during the winters, and they had to use what substitute materials they could find—feeling like conspirators as they did so—but as they made things work, faith in the forefathers' dogmas was loosened. In feeling around for usable raw materials and for suitable methods, he was forced to experiment continually. The research attitude of mind was thus developed, and when he went back to England, it was as a research man, and under the rather unusual condition that discoveries and patents were to be owned equally by Brearley and his employer.

The mental attitude of a research man is nicely expressed in this quotation: "From 1907 to 1914 there was no man living better pleased with his job. It was my business to observe, to experiment, to advise, to criticize constructively, to teach, to discover (if the fates were kind), and above all not to mislead."

In searching for a better rifle barrel, a steel of 0.24 C, 12.8% Cr was made, and in some conditions of heat treatment resisted metallographic etchants. Brearley suggested stainless cutlery. The discussion of the business and patent ownership controversies that arose when, after the usual incubation period, the merit of the new product became evident, is tinged with some rancor of which there is no trace in the account of earlier hardships and vicissitudes.

In 1915 Brearley became works manager of Brown Bayleys, continuing through the war, later shifting to the semi-retirement of consulting work and time for the further development of the philosophical frame of mind the book evidences.

Pages 160 to 165 on the philosophy of specifications should be required reading for every A.S.T.M. committee. A copy of the book might well be handed, along with his diploma, to each metallurgical graduate. To get an education the hard way as Brearley got his by his own efforts is neither necessary nor desirable today, but the independence developed in getting it the hard way is desirable. Something of that spirit of independence might be instilled into youngsters by reading the book.

—H. W. GILLETT

Workers in Metals

The Metal Crafts. *By William H. Johnson and Louis V. Newkirk. Published by the Macmillan Company, New York, 1942. Cloth, 8½ x 11¼ in., 152 pages. Price $2.50.*

This is a textbook for students in public school industrial arts courses in which ability to use one's hands, and, perhaps, some sense of the aesthetic are developed. Making gadgets by hand working of the various metals develops a personal understanding of their qualities and limitations, useful in later life in metallurgical production. The book is easily understood by the youngster and should serve its purpose well. Metal fabrication a generation hence will profit through the training of youngsters in metal-working industrial arts courses.

—H. W. GILLETT

Welding

THE SCIENCE AND PRACTICE OF WELDING. *By A. C. Davies. Published by University Press, Cambridge, England and Macmillan Co., New York, 1942. Cloth, 5¼ x 7¾ in., 436 pages. Price $2.25.*

This is a text book primarily for students in technical training classes preparatory for the City and Guilds examinations given to prospective welders in England. No previous knowledge of physics, chemistry, metallurgy or electricity is assumed, hence quite a proportion of the book is devoted to presentation of extremely elementary facts along these lines.

Discussion of the principles and practice of oxy-acetylene and electric arc welding, and of gas cutting topics to which most space is given is similarly very elementary, while the comments on atomic hydrogen resistance, flash, Thermit welding and use of brazing materials are decidedly sketchy.

Nevertheless, the important fundamentals are clearly expressed and the book is a good introduction for those approaching welding with complete ignorance. Since it was written for just that purpose it is not surprising that neither the metallurgist nor the experienced welder will find much of value in it.

Welding instructors who can show how welding should be done but who are not experienced as teachers of underlying principles are more common than those skilled in both phases. Instruction by a practical welder plus study of this book ought to result in making better welders than when the instructor is long on theory and short on practice, a condition not very rare in trade schools and industrial arts courses.

—H. W. GILLETT

Directory of Associations

Trade and Professional Associations of the United States. *By C. J. Judkins. Published by U. S. Government Printing Office, 1942; obtainable from Supt. of Documents, Washington, D. C. Paper, 9 x 11½ in., 324 pages. Price 70c.*

The cover reads, "A directory of 3,100 national and interstate associations available for national mobilization activities in 1942." This is a recognition that the business and professional groups that have previously banded together for cooperative attention to their joint problems are a force that can be utilized in the war effort.

From it we find that ladder-makers, doll-manufacturers, urban universities, crematories, golf-ball makers, marshmallow manufacturers, postmasters, locksmiths, pickle packers, wooden Venetian blind makers, wrench manufacturers, et cetera, have their trade associations. Miscellaneous associations include the American Assn. of Baseball Broadcasters, American Cryptogram Assn., and National Ski Assn., and in juxtaposition and in the review's mind of not too unequal importance, American Institute of Physics and American Kennel Club. We don't find Ducks Unlimited.

The number of members and types of activity engaged in are given for each group. When you want information in some field and don't know where to turn for it, there's a good chance that there is an association dealing with that field whose secretary will be glad to give you the information. This pamphlet enables you to find that secretary's address.

—H. W. GILLETT

Other New Books

LET'S WRITE GOOD LETTERS. *By Sherman Perry. Published by American Rolling Mill Co., Middletown, Ohio, 1942. Cloth, 5¾ x 8¾ in., 176 pages. Price $1.00.* Prepared for Armco use, this is available to others. It's a good book to have around. Do's and don'ts for accuracy, clarity, and brevity of expression, are forcibly given. Pertinent hints on how to be a good secretary make the book helpful to him or her as well as to the dictator. Report writing gets only a little space, but that little is helpful. People who write articles for publication could pick up pointers too.

MINES REGISTER—VOL. XXI. *Published by Atlas Publishing Co., New York, 1942. Cloth, 6¼ x 9¼ in., 742 pages. Price $15.00.* This is a complete revision of the previous volume which appeared in 1940. The Second World War has given great impetus to the metal mining industry all over the world. Information on mining properties in the Western Hemisphere has been brought up to date. About 4,000 mines are described with 22,000 inactive ones listed. A new section lists all active mines according to their geographical location and in a special section some of the leading non-ferrous metal mining companies are listed.

(Continued on page 366)

Solders

TIN SOLDERS—SECOND EDITION. By S. J. *Nightingale and O. F. Hudson. Published by British Non-Ferrous Metals Research Assoc., London, 1942. Cloth, 6¼ x 10 in., 117 pages. Price $2.75.*

Information obtained since the first edition (and published in the Journal of the Institute of Metals) is added in the second. A good deal of the book has been rewritten. The new data chiefly refer to elevated temperature properties. It is unfortunate that the recent data of the Bureau of Standards (Building Materials and Structures, Reports B.M.S. 58 and 83, and Research Paper R.P. 1465) were not available for inclusion, and especially unfortunate that no real attention has been paid in the book to substitutes for tin in solder or to the lead-tin solders low in tin. Outside of wiping solder, the lowest tin content dealt with in the monograph is higher than the maximum now allowed in the United States for the purposes discussed.

The information relates chiefly to hand soldering. Dip soldering, and automatic soldering as applied in the can-making industry are passed over with bare mention. On the basis of tonnage used, it is difficult to excuse these omissions.

Within its limits, the information on fluxing, control of temperature, and obtaining a suitably thin joint, is sound and useful. There is, however, considerable available information on fluxes which has not been included. As the title indicates, only tin solders are discussed to any helpful degree.

When the third edition is written, it is hoped that it will deal with solders in general and be as comprehensive and up-to-date as one expects a new edition, not a mere reprinting, to be. Evaluation of the place of all the low-melting metals in solder would be much more useful than a type of special pleading for tin in which the eyes are shut to and the mouth is closed about, the existence of good tinless solders.

—H. W. GILLETT

Examining Metals Electrically

THE PHYSICAL EXAMINATION OF METALS. VOL. II. ELECTRICAL METHODS. *By Bruce Chalmers and A. G. Quarrell. Published by Longmans, Green & Co., New York, 1942. Cloth, 5¾ x 8½ in., 280 pages. Price $6.00.*

Like the first volume which was reviewed in the April, 1940, issue of "Metals and Alloys," this second and presumably last volume of the book is written for the metallurgist who has a rudimentary knowledge of physics and who wishes to acquaint himself with some of the modern trends in special physical methods of examining metals. The authors disclaim any attempt at completeness, and the fact that the topics, Magnetism, Electrical Measurements, X-ray Diffraction, The Diffraction of Electrons, The Electron Microscope and Radiography, are each treated in a moderate-sized chapter is evidence that the book is not comprehensive. It is understandable, perhaps, that the authors have discussed in considerable detail those techniques with which they have had considerable experience and have neglected many others with which they are less familiar; the effect, however, is to leave the reader with the impression that there is much to be desired in the choice of material.

The authors have attempted to give the elementary theory of each subject discussed. The chapter on electrical measurements starts off with Ohm's Law, and the one on X-ray diffraction begins with the laws of diffraction in three-dimensional lattices. In general, these treatments are too condensed for the reader who is unfamiliar with the subject and quite unnecessary for those who already know something about the topic. Since the book is not intended as a manual of techniques, more space might well have been devoted to a critical discussion of what can and what can not be done by the various techniques.

Written in clear, understandable language, the book will provide many metallurgists with a relatively easy means of learning about some of those more specialized metallurgical tools that have been developed principally by physicists.

—H. R. NELSON

Selection of Steels

WHAT STEEL SHALL I USE? *By Gordon T. Williams. Published by The American Society for Metals, Cleveland, Ohio, 1941. Cloth, 6¼ x 9¼ in., 209 pages. Price $3.50.*

The book doesn't answer the question, for the answer is, "It all depends." Indeed, it states, "Selection must be made on factors, such as hardenability, price and availability and not because this steel can do something no other can do because it contains 2 per cent instead of 1 per cent of a certain alloying element or has a mysterious name." Further, "The majority of the problems encountered will be mechanical."

With these principles in mind, the bulk of the book relates to such things as fatigue failures, notch-toughness, wear, limitations of existing heat-treating equipment, limitations of case hardened steels, machinability, and the like. The aim is to develop a sound, realistic point of view.

Because it does this in simple language, e.g. "Smart engineering is to try the cheap way first," it is one of the first books the metallurgical engineer should read in connection with conservation and substitution problems. It would be particularly advantageous if Donald Nelson could make everyone concerned with drawing up Army and Navy steel specifications read it.

—H. W. GILLETT

Other New Books

ENGINEERING AS A CAREER. *Published by Engineers' Council for Professional Development, New York, 1942. Paper, 6 x 9 in., 36 pages. Price 10 cents.* An interesting presentation of the scope of engineering, engineering training, professional aspects, and the work done by various types of engineers. (Needs to be brought up-to-date on the functions of metallurgical engineers in selecting materials and processes in the design of finished consumer and industrial goods, in addition to the activities mentioned.)

WELDING AND METAL CUTTING. *Edited by E. Molloy. Published by Chemical Publishing Co., Inc., Brooklyn, N. Y., 1942. Simulated leather, 5¾ x 8¾ in., 112 pages. Price $2.50.* An American edition of a British book dealing with the elements of oxy-acetylene, arc, resistance, and thermit welding, and oxygen cutting. Concise, but quite elementary. Written from the operator's viewpoint.

MAGNETIC TOOLS AND APPLIANCES IN ENGINEERING PRODUCTION. *Edited by E. Molloy. Published by Chemical Publishing Co., Inc., Brooklyn, N. Y., 1942. Simulated leather, 5¾ x 8¾ in., 116 pages. Price $2.50.* Magnetic chucks, clutches, lifting magnets, brakes and solenoids, general principles of magnetizing and demagnetizing are described. Of more metallurgical interest are the sections on Magnaflux testing and magnetic separators. Written in England, the equipment pictured is of British manufacture. The book is of the same type as the one reviewed above.

OEM HANDBOOK. *Published by Office for Emergency Management, 1942, and available in Room 1501, New Social Security Bldg., and from Supt. of Documents, Washington, D. C. Paper, 5¾ x 9 in., 72 pages.* This booklet describes in detail the organization of the War Production Board, the Office of Price Administration and the other constituent agencies of the OEM. Personnel is listed in most cases down to the branch level in each agency. Included are organization charts of the WPB and the Bureau of Industry Branches of the WPB Division of Industry Operations, as well as a chart showing the relationship of the various Federal war agencies.

RECOMMENDED PRACTICES FOR INSPECTION OF FUSION WELDING. *Published by American Welding Society, New York, 1942. Paper, 6 x 9 in., 23 pages. Price 40c.* This report is the result of 2 years' work by the committee on inspection of welding and represents a comprehensive treatment of the many factors involved in the inspection of welds made by the arc and oxyacetylene processes. The subjects covered include: Qualifications of welding inspectors; duties of inspectors; inspection and testing of welded structures; inspection during construction; shop and field inspections; examination of welds; radiographic inspection, hydrostatic testing and magnetic powder inspection. Welding characteristics of both ferrous and non-ferrous metals are discussed. While most of the report deals with the inspection of welds in ferrous material, there is a considerable discussion of the non-ferrous metals, including copper and copper alloys, aluminum and aluminum alloys, and nickel and nickel alloys.

A.S.T.M. STANDARD ON COPPER AND COPPER ALLOYS. *Published by American Society for Testing Materials, Philadelphia, 1941. Paper, 6 x 9 in., 350 pages. Price $2.00.* Presents in convenient form the A.S.T.M. standard and tentative standard methods of test and specifications pertaining to copper and its alloys. Sponsored by Committee B-5, the volume features many specifications that have been recently revised in collaboration with Army, Navy and Government bureaus.

CHEMICAL ANALYSIS BY X-RAY DIFFRACTION (A 4000-CARD INDEX). *Published by American Society for Testing Materials, Philadelphia, 1942. Packed in finished container boxes. Price $50 per set.* Based on the Hanawalt method, this index identifies the 3 strongest lines in the X-ray diffraction pattern of 1300 crystalline compounds.

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